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# Making HPV Vaccines Efficient: Cost-Effectiveness Analysis and the Economic Assemblage of Healthcare in Colombia

Oscar Javier Maldonado Castañeda

*Department of Thematic Studies—Technology and Social Change, Linköping University, Sweden/  
oscar.maldonado.castaneda@liu.se*

## Abstract

Cost-effectiveness analysis is a strategy of calculation whose main objective is to compare for making decisions about the best, the most efficient solution (costs vs benefits) to a particular problem. Cost-effectiveness analysis not only provides a framework to compare healthcare interventions which in practice seem incommensurable; it also performs a set of assumptions regarding the nature of healthcare and individuals' behaviour. This article analyses the role of cost-effectiveness analysis as a device to produce value in the introduction of *human papillomavirus* vaccines to Colombia. In different institutional pathways and decision-making scenarios cost-effectiveness has been the key issue that justified the inclusions and exclusions that such technology entails. Cost-effectiveness justified the definition of girls as the population target and the exclusion of boys from the risks and benefits of this technology. Cost-effectiveness analysis has been a key instrument in the sexualising and desexualising of cervical cancer and *human papillomavirus* vaccines through the rationalisation of economic benefits.

**Keywords:** quantification, HPV vaccines, global health

## Introduction

Cervical cancer is strongly associated with the persistent and untreated infection of specific types of the human papillomavirus (HPV). There are currently two vaccines that protect against the HPV types associated with 70% of cervical cancers – Cervarix® manufactured by GlaxoSmithKlein and Gardasil® by Merck. After three years of debate about their cost-effectiveness, in 2012 the Colombian Government introduced Gardasil® into the Colombian Expanded Programme of Immunisation. Since that year, three million girls in Colombia have received the vaccine.

The cost-effectiveness of this intervention was a central concern for health authorities in Colombia. While the security and efficacy of the vaccines were relatively taken for granted, cost-effectiveness was a matter of debate. The cost effectiveness of HPV vaccines has been internationally a contested issue because of the different elements involved in its calculation. They are one of the most expensive vaccines on the market and are an intervention to prevent a disease with an occurrence period of 20–30 years. Moreover, HPV vaccines are 'competing' with cervical

screening programmes, a complex system of diagnosis and treatment of cervical lesions. For the medical community, cervical screening has significantly reduced mortality for cervical cancer in the countries where it has been implemented (developed countries).

The first study used by the Colombian Government to consider the introduction of these vaccines concluded that, at the international prices of that time (2009), a national HPV programme was not cost-effective (UNAL, 2009: 60). Many voices within the medical community expressed disappointment with these conclusions. However, a legal class action led to a reconsideration of the study results by the government. In December 2010, a citizen brought a class action against the Ministry of Health to protect the rights to public health and security that had been breached because of the non-inclusion of HPV vaccines into the mandatory healthcare plan (POS). As result of this class action, the court recognised that the "Right to Public Health" was breached by omission, establishing a deadline of three months after the ruling to complete new cost-effectiveness studies (Council of State, 2012).

At the end of that year, the Ministry of Health contracted a second study concluding that at the international prices of that time (2011), an HPV vaccination programme using Gardasil was cost-effective (UNAL 2011). Accordingly, the National Committee of Immunisation Practices on behalf of the Ministry of Health approved the introduction of Gardasil into the expanded programme of immunisation. Officially, the national vaccination programme against HPV started in August 2012. The President of Colombia Juan Manuel Santos presided over the campaign launch. In 2013, the Colombian Congress approved Act 1626 to support HPV vaccination programmes in the long-term.

How did the Colombian Government come to overturn their original conclusion about HPV vaccines' cost-effectiveness in the space of three years? Different actors tried to influence in the government's decision: courts, medical communities, pharmaceutical companies, and citizens. However, the decision and its argumentation were developed using the language of evidence-based medicine and cost-effectiveness analysis (CEA).

In this case, any attempt to influence the government's decision had to be presented in terms of numbers, evidence and data. For instance, as I present in this article, one of the most significant changes between the studies was the inclusion of genital warts as a public health concern by means of the quantification of its "burden of disease".

This article analyses the role of CEA in the governing of HPV vaccines in Colombia, describing vaccination policy as an assemblage in which quantified entities have an important role in the production of legitimacy. CEA not only provides a framework in which to compare health-care interventions that seem to resist comparison; it also performs values associated with good policy. In the several scenarios in which this policy is constructed, cost-effectiveness has been the key issue that justified the inclusions and the exclusions that such technology entails. This case explores the reception of these calculation devices in a developing country. It aims to contribute to the literature on statistics and CEA in contemporary politics by showing the role of the calculation of the cost-effectiveness of HPV vaccines in its legitimation of the right public health intervention in Colombia.

Following the movement of the numbers and measurements that express cost-effectiveness from technical reports to the immunisation committee, the Colombian Congress and the Council of State, I describe the transformation and malleability of entities that are regarded as objective and stable and the ways in which numbers are intertwined in affective economies. In this process, cost-effectiveness slowly disappears as a matter of concern and other elements such as prices, prevention and women's empowerment gain importance in the public justification of the intervention. I illustrate this argument by analysing the role of the quantification of genital warts' burden of disease in making Gardasil the most cost-effective option and by expanding on the short lives of some numbers once they travel from CEA to public arenas. Cost-effectiveness becomes an icon to justify the inclusions and the exclusions that HPV vaccines entail: the definition of girls as the population target and the exclusion of boys from the risks and benefits of this technology.

In parallel with the description of this transformation, this article analyses the role of CEA in the production of convoluted relations between sexuality and HPV vaccination. The inclusion of genital warts into the calculation of cost-effectiveness renders visible the sexual character of HPV infection and the hetero-normative assumptions of epidemiologists and health authorities regarding contagion and prevention. In contrast, in public arenas, quantified entities and the reference to cost-effectiveness as a policy value have contributed to “desexualising” cervical cancer. These entities have highlighted the economic and affective benefits of prevention as the focus of the policy.

### Numbers production and value in policy

Science and technology studies (STS) and sociology have shown an increasing interest in studying numbers and the effects of quantification in policy and public affairs. Such work can be understood as an extension of the analysis of the production of numbers and mathematical representations in the history of science (Hacking, 1990) and laboratory studies (Latour and Woolgar, 1986). The sociological analysis of quantification has focused on numbers’ practical uses and the ways in which these are related to wider networks of practices (Desrosières, 1998; Espeland and Stevens, 2009; Fourcade, 2011).

Ian Hacking (1990) in *The Taming of Chance* describes the rise of political arithmetic and the genealogy of concepts that have shaped contemporary policy such as probability and evidence. The rise of a quantitative rhetoric is linked with the development of statistics as a governance tool. Indeed, Porter (1995) has described how different professional groups (accountants, engineers, actuaries, economists and statisticians) construct their expert authority around the use of numbers and quantitative models impacting through such ‘technologies of trust’ as public governance. Numerical operations have been used as strategies to soften political controversies and to produce rhetorical objectivity (Porter, 1995: 206).

Different forms of quantification, but in particular statistics, have been adopted as the

language of the modern state. Policymakers know and represent society through numbers and figures; statistics is a key tool in debates, in the assessment of policy choices, and, increasingly, in the evaluation of government performance (Clark, 2005: 404). The integration of quantification as a strategy of governance relies on configurations that are nationally segmented. National regulations, government structures and the history of the relationship between governments and their citizens shape the role of quantification in governance (Jasanoff, 2004). The extensive development and use of information technologies have increased the production of quantified data in different realms of government and have facilitated the execution of convoluted calculations by means of a wide range of software.

Calculation and quantification in policymaking have an important role in the two-way transit of objects from matters of fact to matters of concern (Latour, 2004). Numbers shape data and objects of knowledge as matters of public interest and transform social and political claims in data, figures and ‘objects’ of knowledge:

Modern social institutions spend considerable time and effort measuring what seems un-measurable and valuing what seems beyond valuation in the service of enhancing their own capacities for calculation, crafting new opportunities for profit, or expanding their jurisdictional authority (Fourcade, 2011: 1723).

On the other hand, the economisation (marketisation) of policy has contributed to the development of quantified practices and devices for decision-making. Authors such as Donald MacKenzie (2006), Koray Çaliskan and Michel Callon (2009) and Tiago Moreira (2012b) have demonstrated the role of economics in the shaping of contemporary governance and our understanding of the social and the market through its devices of calculation and practices of quantification. A concept of value shaped by economics has massively dominated contemporary societies. It has influenced “major infrastructures of contemporary life, like housing, circulation, healthcare institutions, etc., many of which play a crucial role in determining our modes of existence” (Kjellberg and Mallard, 2013: 17).

The analysis of valuation involves “unpacking implicit and explicit normative assumptions that are ‘blackboxed’ through different technical infrastructures (Kjellberg and Mallard, 2013: 17)”. A way of unpacking such infrastructures is to follow the transformation of numbers through their circulation from their technical generation to their public display. Numbers are generated by practices of calculation. STS literature (Desrosières, 1998; Callon and Law, 2005; Verran, 2012) has understood numeric calculation as a three-step development, a game of entanglements and disentanglements. When produced as quantified entities, numbers follow a process of ordering, measuring and generalisation. In this process, they are first indices of a partial order, then they become measures of value (symbols), and finally express a naturalised order (icons). As Verran (2012: 65) has noted, understanding the ways in which numbers are produced and transformed is very important in tracing the transformation of contemporary governance.

Verran (2012) argues that in the analysis of the role of numbers in contemporary governance, indices are crucial. An index is a sign in which the relations that constitute it are open and available for changes and reworking: “It is thus in the indexical zone that the three-step epistemic dance of “modern facts” is most easily undone (Verran, 2012: 66)”. The other two types of signs, symbols and icons partially hide or render invisible their own process of production. Symbols can be understood as those types of signs that need a theory, an explicit set of categories, to be meaningful. For instance, those numbers in technical reports that are justified as faithful accomplishments of formulae; these formulae are a set of relations between several abstract concepts. Although the formula does not reveal the material process of producing numbers, it makes explicit the categories that render them.

As Lampland (2010) notes not all the numbers are produced to express a true fact. Actually, “assuming that the effective use of numbers depends upon their veracity obscures crucial social processes at the heart of modernising practice” (Lampland, 2010: 378). The practical value of some numbers relies on the fact that they are ephemeral, temporary and conditional.

I would add that not just false and provisional numbers are unstable. As I present in this article, numbers that are produced with the purpose of expressing ‘reality’ are not particularly meaningful outside specific contexts. The apparent stability of numbers is the result of their transformation in icons. As I present it, the numbers that express the cost-effectiveness of HPV vaccines, although not considered provisional, are regarded as fragile by those responsible for producing them. Such perception of contingency is related not only to the fast changing input data but also to some features of cost-effectiveness as a calculation device in health policy.

### **Quantification and governance in contemporary healthcare**

Different authors (Moreira, 2012a; Reubi, 2013; Wahlberg and Rose, 2015; Adams, 2016) converge in arguing that contemporary healthcare has been transformed by the use of actuarial, managerial and accounting devices of calculation that have promised a more efficient use of scarce resources. Calculation practices such as cost-benefit analysis and CEA have been used to allocate resources and to make trade-offs between drugs, procedures and diseases that previously had been considered not comparable. The development of health currencies based on the quantification of quality of life has made such trade-offs possible.

The increasing use of QALY (quality adjusted life years) and DALY (disability adjusted life years) has recently attracted the interests of scholars – from anthropology, sociology and science studies – who have perceived that metrics have an important role in the shaping of the contemporary governance of global health. Some of these works have analysed the normative assumptions behind the design of these metrics (Kenny, 2015; Wahlberg and Rose, 2015) arguing that they show a deeper transformation in epidemiological rationality and the governing of life. Other works (Moreira, 2012b; Adams, 2016) have emphasised their role in the economisation (Adams, 2016) of healthcare. For them, QALY and DALY are key elements in the organisation of global health according to principles from the market. These scholars are concerned with the side effects of

7quantification in the provision of “health for all” (Adams, 2016).

The use of these techniques and metrics shows the tensions and particularities of what McGoey and colleagues (2011) have called global health complex; that is, an increasing globalised understanding of health risk accompanied by the involvement of new actors in international health policy advocating for standardisation, efficiency and business-like strategies of assessment and intervention. Such complexity echoes a global assemblage (Ong and Collier, 2005) in which standards and other “global forms” are concrete elements in the configuration of local and specific objects:

The relationship among the elements in an assemblage is not stable; nor is their configuration reducible to a single logic. Rather, an assemblage is structured through critical reflection, debate, and contest (Collier, 2006).

The governing of healthcare by numbers could be understood as an assemblage of metrics, national governments, international institutions and material infrastructures.

This configuration is deeply entangled with other transformations in global and public health such as its pharmaceuticalisation (Biehl, 2012; Mamo and Epstein, 2014) and new engagement with local and national forms of citizenship and regulations (Ecks, 2008; Biehl and Petryna, 2011). An emphasis on quantified and measurable health outcomes has privileged those interventions that can demonstrate their value through clinical trials and CEA. Drugs perform particularly well in this valuation framework, while more holistic approaches have serious problems in reporting their impact and effectiveness in the language of quantification (Adams, 2016). On the other hand, the rise of a quantified regime of valuation in healthcare has produced tensions, conflicts and new relationships with other valuation frameworks such as the law (Foucarde, 2011: 1733). Stefan Ecks (2008) has described the surge of new forms of strategic mobilisation of legal resources by pharmaceutical companies, in which they pretend to be “good citizens” that advocate for patients and citizens’ rights. Other authors (Biehl and Petryna, 2011; Maldonado, 2017) have

described the clash between representations of health as a “Right” and as a matter of calculation and a commodity. In countries such as Brazil (Biehl and Petryna, 2011) and Colombia (Maldonado, 2017) patients have had to appeal to courts in order to get access to prescribed medicines, often in direct opposition to economical valuation about their cost-effectiveness.

How do we approach the assemblages where these devices operate? I argue that a comprehensive study of the quantification (Fourcade, 2011) in healthcare policy asks why and how numbers are produced and in which assemblages they are produced and circulate (Çaliskan and Callon, 2010; Fourcade, 2011). This analysis is necessary in order to follow the production and circulation of information between documents, tracking the transformation of data and numbers, their disentanglement from the calculation spaces in which they are produced and their re-entanglement in new texts by new institutions. I have analysed the technical studies produced by consultants for the Colombian Ministry of Health, memoranda and regulation. Additionally I have interviewed the members of the Committee of Immunisation practice and the experts that developed those studies. This exercise can be understood as reverse engineering. I have traced papers and documents that are quoted as references to support particular claims and data, and I have re-enacted some calculations in order to understand the origin and use of some of these results. Although cost-effectiveness is invoked as the main framework for understanding the social and economic value of HPV vaccines, as I show, the metrics that render visible such value do not travel through these different institutional settings.

CEA as calculation practice depends on the disentanglement of technologies and procedures from their contexts of use in healthcare; these entities are ordered in a calculative space in which they will be transformed and translated into new entanglements as results. In the case of CEA the calculative space will be defined by formulae. A formula is a symbolic representation of the relation between entities that have been quantified. In the same way in which tables and rankings tell stories about modes of ordering, hierarchies, inclusions and exclusions, formulae as calculative



spaces enact rules, assumptions and narratives about the entities that are calculated. This article is an analysis of how methods perform reality, in this case how CEA as a methodology of comparison and valuation produces an assemblage between health, economic value, sexuality, risk, cervical cancer and HPV vaccines.

### **Assembling cost-effectiveness: numbers, courts and viruses**

CEA allows the identification and monetisation of the costs and benefits of a programme. It relates costs to specific measures of effectiveness. CEA is a well-established technique to support decision making in health policy; it has a long tradition in Europe and North America, and in the past decade it has been increasingly used in developing countries. This practice has demanded the development of particular health measurement units such as the year lost life (YLL), the life year gained (LYG), QALY and DALY. These units act as health currencies in the sense that they are used as quantified and interchangeable measures of the value of healthcare interventions in terms of human life (Moreira, 2012b). Health currencies complete the work done by monetary estimations in the calculation of cost-effectiveness, which is a ratio between costs expressed in money and benefits in terms of human life and quality of life.

CEA is a powerful tool in policymaking because it translates different objects and realms into a quantified language whose "value" is perceived as highly visible: money. As Pinch and colleagues noted, the success and credibility of such technique "lie[s] in their ability to continually trade between the worlds of facts and figures and worlds of words and politics" (Pinch et al., 2000: 24). Such capacity to mediate between practices and artefacts has extended their use in contemporary policy. Additionally, CEA enacts future scenarios for policy imaginaries and practices. This is important to decision makers because the benefit and costs of programmes are not limited to the present; on the contrary they are calculated and defined into the future. Economic and health benefits are projected into the future; the current scenario matters because it is perceived as a stage in the enactment of the future (Adams et al., 2009).

Although CEA valuation might be considered as a corollary of the expansion of bureaucratic-legal rule in contemporary democracies, the reception and justification of this tool is related to specific nation-state assemblages. Different countries justify the practice and implement it in a special way (Fourcade, 2011: 1733). In the United States, for instance, cost-benefit methods are widely spread and are perceived as a normative instrument of good democratic governance; while in countries such as France, they are more openly perceived as technocratic contraptions rather than accountability tools (Fourcade, 2011). As I present in this article, CEA in Colombia has been recently introduced into health policy and is perceived as a novel instrument by policymakers that would improve decision-making, increasing the efficiency of policy.

The formula behind a CEA seems quite simple: "typically, analysts subtract costs from benefits to obtain the net benefits of the policy (if the net benefits are negative, they are referred to as net costs)" (Cellini and Kee, 2010: 494). In practice, this is far from simple. Even when the effectiveness is assumed, as in this case<sup>1</sup>, epidemiologists and health economists have to undertake a painstaking process to estimate the costs and to translate clinical trials' effectiveness in terms of populations. In this case, the epidemiologists from Universidad Nacional evaluated the cost-effectiveness of an HPV-vaccine programme. The unit cost of vaccinating one person was known and the probabilities of contagion, transition to cancer and death were estimated from epidemiological data and were calculated in terms of cohorts. The total cost was calculated by multiplying the costs of treatment of one person by the numbers needed to achieve herd immunity in a hypothetical cohort. The expected health yield of such an intervention is expressed in disability health adjusted units (DALY).

These elements are constructed in a transmission dynamic model, usually a Markov chain. The model aims to predict the burden of HPV related diseases in several treatment scenarios: non-intervention, cervical screening only, vaccination only and vaccination and screening. In the model the population is stratified by HPV type and age. Papillomavirus types were split into two groups

for cervical cancers (type 16, type 18 and other low-risk types) and one group for genital warts (type 6 and type 11).

This kind of epidemiological modelling can be understood as a systematic review in movement. The parameters are selected from an evaluation of technical and scientific literature. The probabilities of transition between states, the demographical composition of the cohort, the incidence and prevalence of HPV infection, cervical lesions, genital warts and cancer come from literature and national statistics. The modelling intends to recreate the development of the disease according to the specificities of the 'Colombian epidemiological profile'. Such specificity relies on the origin and location of the input data.

As I noted previously Universidad Nacional developed two studies to determine the cost-effectiveness of HPV vaccines (See table 1). Study 1 (UNAL, 2009) focused on defining the burden of cervical cancer and HPV infection in Colombia,

and in assessing the potential impact of a bivalent HPV vaccine (HPV 16 and 18) in the reduction of the incidence of cervical cancer. In this study, the CEA is based on LLY. DALYs are used to express the burden of the disease but not to determine cost-effectiveness. This study concluded that the most cost-effective strategy is cervical screening and HPV vaccination combined. However, at the international prices offered to the Colombian Government in 2009 (US\$25 per shot) a vaccination programme would be too expensive. The costs are higher than the cost-effectiveness threshold of one GDP per capita. Consequently, the Committee of Immunisations (NCIP) decided to postpone the introduction of these vaccines.

This study is extremely careful in declaring the limitations and contingencies of the analysis. It notes the lack of official data about the national incidence and prevalence of cervical cancer and HPV infection by types. It is stated, moreover, that the frequency of HPV 16 and 18 oscillates

**Table 1.** Summary of the cost-effectiveness studies of HPV vaccines in Colombia developed by Universidad Nacional

<b>Institution (author)</b>	Universidad Nacional	Universidad Nacional
<b>Year</b>	2009	2011
<b>Perspective</b>	Society and Healthcare System	Society and Healthcare System
<b>Vaccine</b>	Bivalent	Bivalent (BV) Quadrivalent (QV)
<b>Disease measured</b>	CIN 1, 2, 3 and cervical cancer	Cervical cancer, CIN 1, 2, 3 and genital warts
<b>Population</b>	Girls 14 years old	Girls 12 years old
<b>Compared with</b>	Screening programme and non-intervention	Screening programme (Pap-test)
<b>Source and data</b>	Bogota cohort, Pueblo Rico Antioq study	Bogota cohort, Mexico
<b>Outcome measure</b>	DALY	DALY
<b>ICER (Incremental cost-effectiveness ratio)</b>	\$1.028,02	ICER/DALY: BV: \$5.314 (\$11.354) QV: \$5.193
<b>Threshold</b>	\$7.400 (Int. dollars) (GDP/per cap)	\$6,294 (US\$) (GDP/per cap) max: (GDP/per capX3)
<b>Protection duration</b>	Life-long (life exp: 85 years old)	Life-long (life exp: 76 years)
<b>Cost vaccine course</b>	\$25 (Int. dollars)	BV: USD \$13,48 (x3) QV: USD \$15,15 (x3)
<b>Screening pattern</b>	annually at 1st two visits (neg. results) then triennial (1-1-3)	annually at 1st two visits (neg. results) then triennial (1-1-3)
<b>Vaccine coverage rate</b>	70%	
<b>Screening coverage rate</b>	50%	
<b>Vaccine efficacy</b>	100%	BV 99% QV 99%
<b>Money</b>	International dollar	US dollars
<b>Conclusion</b>	Non-cost-effective	Both are cost-effective

Source: UNAL, 2009, 2011.

between 52% and 64% in the Colombian female population. More importantly, the study does not “take into consideration the burden of disease produced by genital warts because these lesions are benign and there is no consensus about the degree of disability they produce” (UNAL, 2009: 44).

The class action against the non-inclusion of HPV vaccines in public funded programmes culminated in the Council of State’s intervention. The court assessed Study 1 (UNAL, 2009), rejecting its conclusions and demanding important changes. The court argued that the study should be updated because since 2008 statistics could have changed: “Moreover, it is possible that the biologics (vaccines) have had some changes which could have a different effect regarding their cost-effectiveness” (Council of State, 2012: 44). For the court, another limitation of this study was that it only covered HPV effects in women and not in men; and “there is no analysis of the potential impact of HPV vaccines in other types of cancer” (Council of State, 2012: 44). As a consequence, the court ordered a new study that should include an analysis of cost-effectiveness of HPV vaccines in the prevention of other cancers in men and women. The court set a deadline of three months for the new study. If vaccines are found to be cost-effective according to the new framework, the ministry must include them in the Expanded Programme on Immunisation (EPI). The result is well known; in July of 2012, the Ministry of Health made public the introduction of HPV vaccines into the programme.

Despite the Council of State’s ruling, very few criteria and parameters changed in the second study (UNAL, 2011). After three years most of technical and data limitations are the same. Study 2 extends the analysis of the burden of disease to other cancers related to HPV infection. Nevertheless, these data come from literature reviews; most of them are statistical estimations based on trials, but not official data. The study remains focused on cervical cancer and the cost-effectiveness of strategies for its prevention and treatment. However, it introduces two important changes. It offers a comparison between both the vaccines that entered the market: tetravalent (Gardasil) and bivalent (Cervarix) and calculates

the impact of genital warts, always, in combination with cervical screening. These changes will reconfigure the analysis, enhancing the value of Gardasil, which finally was integrated into the national programme of immunisation in 2012. The second study becomes the main source of evidence provided by the Ministry of Health for the Congress of Colombia in the discussion about the inclusion of boys into the vaccination programme.

Although the second study was strongly supported in public by the committee of immunisation practices, during the interviews some of the members expressed concerns with the ways in which data were selected and the subtle influence of the manufacturers of Gardasil. Such members complained about the exclusion of two studies published in *The Lancet Oncology* regarding the higher cross-protective efficacy of Cervarix. Cross-protective efficacy is the development of immunity against other types of oncogenic HPV that are not the primary target of the vaccine. This factor would have increased the efficacy of Cervarix as against Gardasil, potentially changing the CEA results. This discussion illustrates the role of companies in shaping these calculations but also the difficulty of presenting evidence about their involvement in policy. Despite this concern, once the decision was made public, committee members have maintained public consensus regarding the cost-effectiveness of Gardasil.

The production of numbers by CEA shows us the plasticity of quantified entities, their power and their temporality. In what follows, I will briefly illustrate this argument by analysing the role of the quantification of genital warts’ burden of disease in making Gardasil the most cost-effective option and by expanding on the short lives of some numbers once they travel from CEA to public arenas. Cost-effectiveness becomes an icon to justify the inclusions and the exclusions that HPV vaccines entail: the definition of girls as the population target and the exclusion of boys from the risks and benefits of this technology. This exemplifies the role of quantification in the reconfiguration of disease through the rationalisation of economic benefits. In this case, CEA is key to the sexualising and desexualising of cervical cancer and HPV vaccines.

## Genital warts and DALYs: Assembling matters of concern through economic valuation

Epidemiology had noted cervical cancer displayed a profile similar to STDs (Bosch et al., 2002: 246). During the second half of the twentieth century research about cervical cancer was focused on finding a cause linked to STD; syphilis, gonorrhoea and herpes simplex virus type 2 (HSV2) were hypotheses. Even sperm was considered as a possible cause of cervical cancer, known as the “male factor” (Reid et al., 1978; Reynolds and Tansey, 2009). The definition of cervical cancer as an STD and of vaccination as a tool of prevention shaped the models and the studies to define the cost-effectiveness and pertinence of HPV vaccines.

In CEA, HPV vaccines have been understood as prevention tools for cervical cancer. Reference to other cancers related to HPV infection – such as throat and anal cancer – is marginal in policy-makers’ discourses and technical reports. Just one other disease has been rendered visible in the discussions about HPV vaccination: genital warts. The consideration of genital warts as a public health concern has been controversial. For years, this condition was considered benign and has become a “health” problem only during the last ten years, in close connection with the molecular design of Gardasil (HPV 6 and 11). Protection against genital warts became an advantage for Gardasil regarding its competitor Cervarix. In parallel with the licencing of Gardasil, in several countries the economic analysis of the burden of genital warts was undertaken to show the possible impact of this vaccine in terms of cost reduction for healthcare systems (Hillemanns et al., 2008).

In Colombia, regional health authorities have claimed genital warts are a serious clinical issue, particularly in those towns and provinces affected by war. The army medical service reported to the immunisation committee that genital warts are a common condition in male soldiers. The political and clinical interest in genital warts contrasts with the lack of studies and epidemiological data about their incidence, costs and treatment. This problem is not exclusive to Colombia; information about the incidence, prevalence and treatment costs of genital warts is relatively scarce compared to the

data about other maladies associated with the HPV infection. Even the study used as “evidence” to define the parameters of the cost-effectiveness model in relation to genital warts (Hillemanns et al., 2008) notes the difficulties of gathering information about genital warts in Germany, where the study was conducted. This research team decided to calculate the incidence and costs of genital warts in Germany through the analysis of a statistically representative sample.

The numerical enactment of genital warts became the key element in the differentiation and added value of Gardasil in the analysis of cost-effectiveness. Genital warts are presented as a quantified burden of disease expressed in DALY. DALY as a measurement unit of disability was considered the right tool to value the burden of a disease whose outcomes were not fatal. It allows a more visible differentiation between vaccines to be produced (see Tables 2 and 3). In terms of deaths avoided by vaccination, the performance of both vaccines was impressively similar. According to the second study (UNAL, 2011), if tetravalent vaccine is compared with no intervention, in a cohort of 450,000 women this vaccine avoids 8,783 deaths from the 9,593 deaths that could happen without any intervention. In the same scenario, bivalent vaccine avoids 8,785 deaths. In contrast, when DALYs are introduced the gap between vaccines is rendered visible. Tetravalent vaccine prevents 1,054 DALYs (bivalent vaccine 1,013 DALYs). Although this difference is not very wide (41 avoided DALY), it is still greater than the gap in terms of the reduction of mortality.

DALY is calculated through a set of weightings defined in relation to the disability that a disease produces. In the second study from Universidad Nacional (UNAL, 2011) such weightings are taken from the *Victorian Burden of Disease Study* (VSG, 2001) (see Table 4). These weightings assign an important burden of disability to terminal stages of cervical cancer (up to 0.95 on a scale where 1 is death) and to the consequences of early treatment (0.43).

Although these data come from a context of healthcare attention completely different from the Colombian one, they are widely accepted by public health experts as an approximate measure of the effects of the disease on human function. On the contrary, the nature of genital warts as

**Table 2.** Incremental cost-effectiveness of HPV vaccination in Colombian women, taking into account genital warts. Base case

	Costs/US\$	Increment costs	LLY	LYG	DALYs	Avoided DALYs	ICER: US\$/LYG	ICER: US\$/DALYs
Non-intervention	7,495,699		9,593		11,453			
Screening	56,114,451	48,618,752	1,191	8,402	1,506	9,947	5,787	4,888
Screening + Bivalent	62,754,454	55,258,755	808	8,785	1,054	10,399	6,290	5,314
Screening + Tetrav.	61,712,199	54,216,500	810	8,783	1,013	10,440	6,173	5,193

Source: (UNAL, 2011).

**Table 3.** Incremental cost-effectiveness of HPV vaccination in Colombian women, taking into account genital warts. Competitive analysis

	Costs US\$	Increment costs US\$	LLY	LYG	DALYs	Avoided DALYs	ICER: US\$/LYG	ICER: USD/DALYs
Non-intervention	7,495,699		9,593		11,453			
Screening	56,114,451	48,618,752	1,191	8,402	1,506	9,947	5,787	4,888
Screening + Tetrav.	61,712,199	5,597,748	810	381	1,013	493	14,692	11,354
Screening + Bivalent	62,754,454	1,042,244	808	2	1,054	-41	21,128	Dominated

Source: (UNAL, 2011).

a disease with an important burden has been contested. There is no defined weighting for this condition within the technical literature about burden of disease (WHO, 2012; VSG, 2001). As I noted previously, even Universidad Nacional's first study pointed out that such condition is a "benign" infection.

In the second study, data are not provided about the assigned weight of genital warts in the calculation of DALY. Nevertheless, if the calculations are re-enacted it is possible to note that the disability value assigned is very low; just 41 DALYs are assigned to 8,410 episodes of genital warts.

Because genital warts are not a fatal condition it is possible to estimate that the assigned disability weight was 0.0048. This weight is slightly higher than the lowest weighting assigned to a disease by the Victorian Burden of Disease (VSG, 2001), which is the long-term effect of moderate burns. The concern for the disease burden of genital warts is a consequence of the introduction of HPV vaccine and the claims of added value of Gardasil. Even within the immunisation committee, tetravalent critics argued that the genital warts burden was part of the strategy of Merck to add value to its vaccine.

**Table 4.** Disability weightings associated with cervical cancer

Cervix Cancer		
Diagnosis and primary therapy	0.430	Provisional weight based on Dutch weights
State after intentionally curative primary therapy	0.200	Provisional weight based on Dutch weights
In remission	0.200	Provisional weight based on Dutch weights
Disseminated carcinoma	0.750	Provisional weight based on Dutch weights
Terminal stage	0.930	Dutch weights for end-stage disease

Source: UNAL, 2011.

The consequences of introducing genital warts into the national immunisations committee's calculations were very significant. First, they increased the value of HPV vaccines, because of the estimated costs and burden of disease that could be prevented through vaccination. Second, they constituted a differential between vaccines. Only Gardasil prevents against cervical cancer and genital warts. Third, the emphasis on genital warts not only increased the value of the tetravalent vaccine (Gardasil); at the same time, it overshadowed the possible impact of this vaccine on other cancers most of them related to non-heteronormative sexualities.

In the technical reports, the tables that summarise the results of modelling – as calculative spaces – preserve some of the contingency of these calculations. In particular, they render visible the narrowness of the difference and the effort of raising genital warts as a matter of public health. However, once these data are moved from technical reports to the technical committee, such contingencies and indexicalities (Verran, 2012) disappear. The different elements that are displayed in the calculative spaces of the CEA are reordered in a coherent and linear narrative whose conclusion is the selection of tetravalent vaccine (Gardasil) as the right tool. As is noted in the minutes of the NCIP:

In a cohort of 430.859 women, 9.137 cases of cervical cancer and 8.410 episodes of genital warts can happen without any intervention. Cervical cancer could cause 6.436 female deaths. The Colombian cervical screening programme would avoid 3.744 deaths. Any alternative to vaccination is cost-effective compared with non-intervention. However, in a competitive analysis, screening plus bivalent vaccine are dominant alternatives. Meanwhile, tetravalent vaccination plus screening is the most cost-effective option, being under 1 GDP per capita (ICER: US\$2395 per DALY) (Ministry of Health, 2012a. SGC-F03 3 May 2012).

The committee concludes based on this analysis that “in a competitive scenario and taking into consideration genital warts without cross effective protection, the vaccination with tetravalent is the most cost-effective strategy. ICER: US\$1.348/DALY” (Ministry of Health, 2012a. SGC-F03 3 May 2012: 10).

The enactment of genital warts in DALY was the differential element that defined the selection of the tetravalent vaccine (Gardasil) as the right tool for EPI in Colombia. Curiously, DALYs and genital warts, main actors in CEA, will be rendered invisible in the movement of data and matters of fact towards more public arenas: media, Congress and vaccination campaigns. Other numbers, particularly prices, will surge as the quantified entities express the value of HPV vaccination. Cost-effectiveness will be detached from its numerical expressions to become a word, an icon of the calculations that legitimised the selection of this vaccine.

### **Icons, prices and the affective entanglements of calculation**

In November 2012, the Congress of Colombia asked the Ministry of Health for a technical concept about Bill 260 of 2012. The bill had suggested “the National Government must guarantee the free and mandatory vaccination against HPV for all boys and girls between 9 and 12 years old”. Based on the second study (UNAL, 2011) the Ministry of Health argued that the vaccination of boys is not cost-effective.

In the technical concept (memorandum) presented by the Ministry of Health to the Congress of Colombia, the legitimacy of the current vaccination programme is supported through data about the costs of the current treatment of cervical cancer and genital warts and the savings that HPV vaccine could generate:

Universidad Nacional estimated that the costs of observation of a female cohort for genital warts are US\$5.8 million, US\$1.0 million for CIN I (Low risk), US\$24 million for CIN II and III and US\$13.4 million for cervical cancer at any stage. The additional costs of prevention and treatment of this disease are US\$117.6 million per year (Ministry of Health, 2012b: memo 201221102384491).

However, in this memorandum the cost-effectiveness of the Colombian vaccination programme is not explained using measurements of cost-effectiveness such as ICER or DALY, neither are the numbers to calculate the effect of vaccinating boys provided. Instead, the Ministry of Health

presents a selection of key papers in which it is argued that the vaccination of boys is not cost-effective (Figure 1).

From these studies data or figures are not selected; the studies themselves are evidence of the loss of cost-effectiveness in HPV vaccination by extending the programme to boys. The Ministry of Health notes the vaccination for boys is not recommended because “such strategies are more cost-effective when they are focused on women to the extent that boys are protected by the herd effect” (Ministry of Health, 2012b: 1).

This last claim from the Ministry of Health materialises the inclusions and exclusions produced during the different entanglements and disentanglements that cost-effectiveness calculations entail. The promise of extended protection to boys through the herd effect from girls’ vaccination renders visible the heterosexual sexualising of HPV vaccines. Nevertheless, as I have shown before, such sexualising is limited only to decision making and experts’ arenas. In media and vaccination campaigns, the Ministry of Health and the EPI have tried explicitly to de-sex HPV vaccines, presenting them as an anticipated treatment against cervical cancer and as a means of empowering girls. Genital warts and the debate about cost-effectiveness, key factors in the process of decision-making, will go into the shadows as “technical details”. Meanwhile, cervical cancer and gender inclusion will be integrated into the presentation of the vaccine in public arenas and media.

Once the committee’s decision is enacted, DALYS, formulae and tables disappear. The decision will be justified in public arenas using

disentangled data about the impact of cervical cancer in public health and the reduction of female mortality that the HPV vaccines promise. Although cost-effectiveness will continue as a source of political legitimacy, its presence becomes iconic in the sense defined by Verran (2012) regarding numbers. That is, the category and the measurement unit are treated as indistinguishable. Numbers and figures about the cost of the HPV vaccine, and its estimated impact on the reduction of cervical cancer, are read as evidence of the effectiveness of this technology without any further discussion about the meaning of these elements and the ways in which they were calculated. Cost-effectiveness justified the definition of girls as the population target and the exclusion of boys from the risks and benefits of these drugs.

New numbers are attached to these accounts. The campaign “Haría lo que fuera” sponsored by Merck suggested a trade-off between daughters’ health and lives and the potential (economic) costs to guarantee their protection. This campaign was online between 2011 and 2014 (Maldonado, 2017). The campaign Haría lo que fuera [Everything I can] offers mothers a scenario of calculation in which the benefits and costs of protecting their daughters’ health should be evaluated. The campaign entangles data about cervical cancer risk and HPV infection, testimonial footage about women’s future plans and “dreams” and mothers’ care and responsibility. Although an explicit price is absent from this campaign, the value of HPV vaccine is enacted in relation to the pricelessness of health and the moral duty of affording HPV vaccines despite their price. Another example is the political advertisement produced by the

The quoted papers are (this is the bibliographic notation used in the memo):

“Evaluating Human Papillomavirus Vaccination Programs” in: *Emerging Infectious Diseases*, 10 (11) Nov., 2004;

“The value of including boys in an HPV vaccination programme: a cost-effectiveness analysis in a low-resource setting”;

WHO position paper about the introduction of HPV vaccines (2009):

“Population-wide vaccination against human papillomavirus in adolescent boys: Australia as a case study”.

**Figure 1.** Memorandum 201221102384491. Technical concept from Ministry of Health to Colombian Congress about Bill 260 of 2012

“Movimiento Independiente de Renovación Absoluta” MIRA (<https://www.youtube.com/watch?v=uRBuBBnzkm>), one of the political parties involved in the promotion of HPV vaccination through the Colombian Congress. This material gathers many elements that have shaped the discourse of politicians and government about HPV vaccines, including anticipation and citizen rights.

This advertising was produced for the election of Congress in 2014. In the commercial, two references are used to enhance the value of vaccination. One is a girl writing ‘dreams’ in her diary. Professional and personal success (becoming a doctor and getting married) are complemented by an expectation of good health, in this case being free of cervical cancer. Then the message is directed to parents: they should consent to vaccination in order to protect their daughters’ dreams. HPV vaccination became a key element in assuring professional and personal success based on ‘contemporary’ ideals of being a woman: a powerful amalgam between being a mother, a wife and a successful professional.

The other reference in the advertising is the price of the vaccine expressed as the amount of money saved by the families through State intervention. The amount saved is COP800,000 for three doses; this figure is presented with reference to the Act 1626 [2013] that guarantees free HPV vaccination. Finally, the video finishes with the MIRA party’s logo. The figure of COP800,000 (US\$264) is particularly meaningful in a context in which the minimum wage is COP616,000 (approx. US\$200 per month) and measurements of poverty are based on individual income. According to the Colombian National Department of Statistics (DANE) the poverty threshold for 2012 was COP202.083 per month. This context highlights the role of pricing (economic value) in the enhancement of the (social and affective) value of public vaccination. In this material, through explicit reference to the market price of the vaccine, politicians are connecting economic value to care and parental protection. HPV vaccines are portrayed as an affective and economic investment.

## Conclusion

CEA as a device of calculation involves the disentanglement of entities and its reordering in a new calculative space. Prices, technologies, populations and health technologies are disentangled from other contexts and reordered through the rules and dynamics enacted in formulae. CEA has been particularly important in contemporary decision making for its capacity to transform a political process of selection of alternatives of healthcare into an ‘objective’ calculation. Such movement of objects requires the development of languages that facilitate the translation and commensurability of (in)commensurable entities. In the case of healthcare, measurement units such as DALY, QALY and LLY have the role of quantifying the effects of technologies and drugs in terms of improvement in quality of life.

The introduction of HPV vaccines in Colombia is a good case in which to trace the ways that these calculation practices are reshaped locally. CEA not only provides a framework to compare healthcare interventions that seem to resist comparison; it also performs values associated with good policy such as objectivity and efficiency. In the several scenarios in which HPV vaccination is presented, cost-effectiveness has been the key argument that justified vaccination as the right intervention for the Colombian population. Additionally, the numbers generated by these practices of calculation are entangled in affective economies. In Colombia, these numbers have enacted representations of care and have contributed to the development of convoluted relations between sexuality and HPV vaccination.

The inclusion of genital warts in the calculation of cost-effectiveness contributed to rendering visible HPV infection as a sexually transmitted disease. At the same time, it reinforced heteronormative assumptions about HPV contagion that are inscribed in the models. Because the epidemiological models are centred in cervical cancer, they only recreate scenarios of contagion and prevention based on heterosexual transmission of the virus. The model assumes that men are protected from HPV infection by the herd immunity of the female population, excluding men who have sex with men from the calculation.



CEA has a very important role in the presentation of particular diseases as public health concerns and in rendering visible the value of healthcare procedures and technologies. In Colombia as in other countries, genital warts became a public concern through the production of numbers about its burden of disease and the economic costs of their treatment. Measurement units such as DALY have an important role in the expert characterisation of this condition. Epidemiologists use DALY to express the subtle public health benefits of genital warts prevention. Nevertheless, these metrics are useful in very limited contexts. Beyond expert arenas, DALY is not used to express cost-effectiveness. In more public arenas, some numbers, figures and papers become icons. They are themselves presented as the evidence that legitimates decision making without reference to the data and the involvements that they encompass.

Other numbers such as prices have an important role in the development of public narratives about care and responsibility in HPV vaccination. Public campaigns have involved narratives about reciprocity, costs and care, in which price has operated as an element to enhance and highlight the responsibility of parents to their daughters, healthcare providers to their patients and governments to its citizens. From the perspective of public vaccination programmes, vaccines are perceived to be interventions by the State. These narratives have reproduced practices of government in which rights are understood as gifts; such style of governing has characterised many of the Colombian State's actions.

This case has shown how interest in cost-effectiveness is restricted to experts' discussion and committees' decisions. In public arenas, cost-effectiveness as an argument loses its rhetoric appeal and is overshadowed by concerns about price and care. The main interest for health authorities in public arenas seems to be to show the benefits of prevention and to desexualise cervical cancer. The connections between sexuality and HPV vaccination are avoided by health authorities in order to prevent potential public resistance to vaccination, particularly among conservative groups that perceive it as encouraging early sexual relations.

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## Note

- 1 HPV effectiveness is assumed. This is a black box that I will not open in this article. There are more than 100 types of HPV, of which almost 20 types are considered as oncogenic. HPV vaccines protect against two types (16 and 18) associated with 90% of cases; however the incidence of this infection varies geographically. HPV 16 and 18 are the most prevalent types in Europe and North America. The committee and the studies in Colombia assume the vaccines are safe and effective. They attribute an effectiveness of 99% to the calculation.

# Domesticating In Home Displays in Selected British and Norwegian Households

Tanja Winther

*Centre for Development and the Environment (SUM), University of Oslo, Norway/  
tanja.winther@sum.uio.no*

Sandra Bell

*University of Durham, UK*

## Abstract

The paper uses qualitative data from Norway and the United Kingdom to understand the new technology of In Home Display monitors as a material object loaded with meaning and norms that may affect social practices and relations. The displays are designed to encourage householders to reduce electricity consumption. In contrast to technologies associated with 'smart meters', the monitors under study cannot be used for controlling or automatising various types of electricity consumption, but these devices nonetheless often form part of 'smart grid solutions'. A large part of the research in this area has attempted to quantify the impact of displays, and qualitative research focusing on the users has also mainly sought to explain why - or why not - the introduction of displays has resulted in reduced household consumption. This paper follows a more open approach to the introduction and impact of displays by paying attention to the existing routines and social practices into which the display enters and potentially becomes integrated and domesticated. We examine to what extent ideas and norms inscribed in the display continue to have a bearing on the household moral economy and internal dynamics as the objects are negotiated and taken in use in British and Norwegian homes. Drawing on earlier studies that have sought to combine practice and domestication theory for understanding displays, the study's novelty lies in its focus on the materiality of displays and social implications thereof, and its analysis of the social status of this object in two different contexts.

**Keywords:** In Home Display, domestication, norms, moral economy, social dynamics, electricity consumption

## Introduction

During the past century European homes were a site of rapid sociotechnical change closely associated with electrification (e.g. Pantzar, 1997; Shove, 2003). In recent decades a marked step change has occurred with the introduction and ubiqui-

tous adoption of digital technologies (Ropke and Christensen, 2013). This has involved not only the use of computers and mobile phones but also other items using small display screens for communicating information to users. One type of

digital technology to enter the domestic sphere is the In Home Display (IHD), which is a monitor that can be used in combination with either conventional or smart meters. The development and promotion of displays signal expectations for a new practice by which householders can monitor and potentially reduce their electricity consumption. By interacting with an IHD people can observe the amounts of electricity consumed and observe the costs. Consumers can also calculate the cost of using specific appliances and choose whether to defect from the practices they uphold (Westskog et al., 2015). Displays are often associated with the cluster of technologies referred to as 'smart meters' and 'smart grids', but those under study cannot be used for controlling or automatising electricity consumption. Within smart grid configurations, consumers can use displays to respond to shifting market signals across different time periods, implying increased proximity between customer and suppliers.

Policy makers in the UK and Norway are backing the uptake of the IHD (Department of Energy and Climate Change, 2015; Inderberg, 2015: 102) as one means of delivering low carbon electricity targets, expecting it will encourage more sustainable patterns of consumption. Electricity is an invisible substance (Lindén et al., 2006; Burgess and Nye, 2008; Shove, 2003) with costs that are unseen until the bill arrives. Without displays or other feedback mechanisms, the planned roll-out of smart meters, together with automated payments, renders manual registration of consumption redundant and increases the risk of reducing people's awareness of the links between energy use and resulting consumption (Westskog et al., 2015: 5432).

In this paper, we focus on the display as a material object potentially loaded with meaning and norms (Bourdieu, 1977; Miller, 1994, 1998; Pantzar, 1997) as it is introduced into selected homes in Norway and the United Kingdom. Our aim is to understand the domestication of IHDs (Pantzar, 1997; Silverstone, 1994; Lie and Sørensen, 1996; Berker et al., 2006)<sup>1</sup> and how this changes household routines and social relations. More specifically, we examine to what extent the norms promoted through the display and mediated through its script<sup>2</sup> (Akrich, 1994)

continue to matter as people integrate and relate to the object in everyday life. Moreover, we want to know how the incorporation of displays potentially affects the households under study, their routines for using electricity for domestic services at home and the ways household members relate to each other. Also important is how people adjust, manipulate and work on the technology to include it in their lives in a meaningful way that confers ownership (Lie and Sørensen, 1996). Displays are currently promoted by policy makers to enhance sustainable consumption and efficient resource use. However, they are not necessarily 'objects of desire' (Pantzar, 1997) for which appropriation is driven by demand; thus, we keep the possibility open that displays become rejected or 'dis-domesticated' (Sørensen, 1994: 7). Rather than anticipating that IHDs are a suitable tool for achieving societal goals, we argue for the need to first scrutinise the interplay between displays, the household moral economy, i.e. the material basis on which households create themselves (Silverstone, 2006: 236–239), and the ongoing social dynamics that reveal processes by which displays are domesticated.

## Literature review

The body of social science literature on how people use In Home Display (IHD) has grown incrementally since the turn of the century. For example, a review of intervention studies aimed at household energy conservation (Abrahamse et al., 2005) concluded that studies of IHD appear to demonstrate positive potential in terms of savings. The underlying hypothesis in these kinds of studies (and policies that promote displays) is that the monitors may be used to mitigate the assumed "information deficit" (Wilhite and Ling, 1995) by providing increased visibility of electricity, and thereby lead households to implement energy-saving measures. Later reviews of IHD pilots have quantified the potential savings (e.g. Darby, 2006), also warning that such findings must be treated cautiously (Faruqui et al., 2010) and arguing that feedback information works best when it is interactive and digital, delivered regularly, tailored to the householder and presented simply (Vine et al., 2013). See Westskog et al. (2015) for a summary of

studies whose main purpose has been to identify barriers and potential energy savings through the use of displays as well as studies that highlight the importance of looking at the socio-economic, material and cultural context in which the display is introduced (e.g. Hargreaves et al., 2010; Carlsson-Kanyama and Lindén, 2007; Schleich et al., 2013; Oltra et al., 2013; Buchanan et al., 2015).

Stengers (2013) offers an important critique of the trend to delegate responsibility for IHDs to ensure energy savings. Stengers considers in detail the work on IHDs of three qualitative researchers and their associates, including herself, whose studies on householders had been “using small samples across three continents (UK, US and Australia)” (Stengers, 2013: 81). She argues, firstly, that displays only reveal a limited and sometimes marginal share of the household’s total energy consumption. Consequently, “energy feedback focuses householders on a narrow range of energy-saving actions that define what energy saving is, and more problematically, what it is not.” (Stengers, 2013: 78) Secondly, the reviewed research found that the effect of “energy feedback is limited by seemingly non-negotiable practices which vary substantially between households” (Stengers, 2013: 81). This resonates with proponents of practice theory (e.g. Shove, 2003; Wilhite, 2008) who maintain that people tend to be more concerned with convenience and comfort when performing energy-related household practices than energy use per se. These household practices are subject to other forms of communicated judgements that may contradict and compete with the feedback provided by the IHD (Stengers, 2013: 90). Thus the effect of IHDs can only be expected to occur in situations in which “energy itself” matters, as it does strategically to low-income families who are more motivated to pay more attention to their consumption of electricity compared to other groups (Stengers, 2013: 89, 93; see also Darby, 2012 and below). Another critical review paper by Buchanan et al. (2015) also questions to what extent IHDs have the desired effect (of reducing consumption) and argues that certain forms of feedback to householders can legitimise usage at current levels or even increased consumption through rebound effects. The authors are not very optimistic about

achieving reductions in consumption through display and point to the need to take the diversity of users into account when inscribing the norm to reduce consumption into the design of IHDs.

In the present work we argue that prior to addressing the question of energy savings, it is vital to understand the various steps in the domestication process in terms of how and why such devices become integrated in the routines of everyday life. To what extent is their design and embedded norms compatible with the moral economy of households (Hargreaves et al., 2013; Stengers, 2013; Buchanan et al., 2015; Nyborg, 2015)? The term ‘moral economy’ is common in economic anthropology to connect households’ acquisition and deployment of resources to wider social relations and cultural meanings. The concept also has a central position in domestication theory, where it positions the household “as part of a transactional system, dynamically involved in the public world of the production and exchange of commodities and meanings” (Silverstone et al., 1992: 19; see also Silverstone, 2006: 236). Commodities that transit the porous and shifting boundaries of the household (Bell et al., 2015) are evaluated, and as such form part of a moral project through which the household is ceaselessly reproduced by its members, in tandem with relatives, friends and neighbours. Silverstone et al. (1992: 26) argue that the appropriation of an object is of no wider consequence “unless it is displayed symbolically as well as materially” to audiences outside the household, expressing the protagonists’ adherence to values that are shared in the wider cultural context.<sup>3</sup> We will examine whether people make reference to particular values when using the display – for example sustainability or modest resource use. Following Silverstone (1994), we will also examine whether the display has a ‘double articulation’ in terms of both being a physical object with associated meanings as well as a mediator of a particular type of information that links the household to wider cultural contexts.

The In Home Display represents a specific type of technological object, which relatively few studies have approached through the application of domestication theory. Hargreaves et al. (2010: 6117-6118) draw on the framework to

see how monitors become “domesticated in the physical domain, social relations and cultural practices of each household”, when and why the displays were monitored and how this affects the temporal rhythm of energy-consuming practices. In the case of smart technology including displays, Nyborg (2015) and Wallenborn et al. (2011) offer treatments of domestication while also drawing on social practice theory. While building on this work, no study has yet, to our knowledge, systematically scrutinised the domesticating of In Home Displays while drawing on cross-cultural material and providing an in-depth discussion of the social status of this particular object. For this purpose, we also draw on Pantzar (1997) who describes how new objects enter the domestic sphere. He distinguishes between ‘novelties’ and objects that replace older products. The latter’s acquisition is socially legitimised through direct comparison between the old and new object in terms of functionality and aesthetics, and the replacing object thus enters an established practice. In contrast, ‘novelties’ are not driven by some basic need or vital practical function, but rather through sensation, pleasure or luxury (Pantzar, 1997: 54).

The domestication framework commonly includes four analytical steps (Silverstone et al., 1992), firstly the *appropriation* of displays through negotiations between household members and considerations that lead to acquisition.<sup>4</sup> Displays are not appropriated for the same reasons as desirable market goods, and as we will show, this has a range of implications. The second step is referred to as *objectification*, i.e. the spatial location and integration of the technology within the household. Thirdly there is the *temporal incorporation and use* of the technology in everyday life, and fourthly, *conversion* which signals to what extent and how the technology has the status of reflecting the identity, aspirations and cultural values of households (or some of its members).<sup>5</sup> The domestication framework will also reveal the need to focus on recruiting processes when conducting field experiments in the realm of energy.

## Electricity in Norway and the UK: Technical and socio-cultural background

### Norway

The high share of hydropower production (99%) in Norway makes most Norwegians think of electricity as intrinsically renewable while in reality the electricity system is interwoven with European countries such as the UK that produce electricity through fossil and nuclear sources (Winther and Bouly de Lesdain, 2013). Because electricity in this view is detached from environmental problems, most people do not see the purpose of reducing electricity consumption to mitigate climate change. Given the generally high level of affluence in Norway, this implies that the two most often noted reasons for people’s motivation for saving electricity – reducing costs and environmental concerns – often do not apply (Winther and Bouly de Lesdain, 2013). Due to the historically easy access to hydroelectric power, most households use electricity for space and water heating (Aune, 2007), as well as for cooking. As a result, the average electricity consumption per household is as much as 16 000 kWh per year (Statistics Norway, 2012), which is the highest in the world.

Many Norwegians have previous experience with using devices similar to the In Home Display. Up to the 1980s many utilities employed a two-step tariff (referred to as “H3”) based on power outtake to reduce the peak loads. Affiliated with this tariff (mandatory) was a wattmeter in the form of a screen and an arrow (simple speedometer) fixed on the kitchen wall to show when the household exceeded the limit for “normal” consumption to a level of consumption which was charged extra per unit (Westskog and Winther, 2014: 99). This socio-cultural heritage has important bearings on the way many Norwegians respond to appeals to save electricity and potentially affecting their domestication of displays. In the planned roll-out of smart meters in Norway there is no requirement that IHDs must be provided to households. A central question is whether and why people would want to acquire displays.



## United Kingdom

In the UK, 24.6% of generated electricity comes from renewable resources (UK Energy Statistics, 2016). There is a high level of dependence on gas-fired power stations. Electricity generation in the UK is intended to move towards renewable generation, but current plans towards achieving this goal are controversial. Fossil fuels are likely to power the major portion of UK electricity generation for the foreseeable future. This anchors the question of carbon emissions and their contribution to climate change more firmly within UK public discourse on electricity than is the case in Norway with its predominance of hydroelectric power production.

Technologies and fuels for space heating also differ in the two countries. The UK has a deeply entrenched incumbent regime of wet-based, gas-powered domestic hot water and heating systems (Hoggett et al., 2011), and 90% of the housing stock have central heating systems with a majority (91%) fuelled by gas (DECC, 2013). With the UK importing close to half its natural gas, government policies currently plan for reliance on gas for domestic heating to shift to electrical powered heat pumps that extract thermal heat from the air or the ground.

In partnership with the utilities, the UK government is set on installing 53 million smart meters equipped with separate IHD monitors in all homes and small businesses by 2020 (DECC and OfGEM, 2011). This move is intended to encourage consumers to control their energy use and to develop awareness of the times of day when they consume electricity.

## Methods

The material for this paper derives from interviews and face-to-face research with householders in Norway and the United Kingdom in 2013 and 2014. Through the research project, all the households had IHDs installed in their homes by a junior researcher even though the technology is designed for self-installation. The material was collected approximately three months after installation.

As detailed below, the empirical material consists of:

- 24 in-depth interviews with households in Røverkollen, Oslo, Norway
- 5 focus group discussions (21 participants) and 9 questionnaires, in the North-East of England

We first installed displays in the Norwegian homes and successively conducted in-depth, semi-structured interviews with these householders. The topics included overall issues such as people's perceptions of electricity, the environment and energy savings. To learn about people's situation more broadly, we asked what living "the good life" means to them, and followed up by asking how energy relates to the good life. We also asked specific questions about the displays, such as why they had wanted to join the trial/acquire the display, who had taken the initiative, its physical location, various members' interaction with and assessments of the display, and to what extent they talk about the display within their wider social networks. We were also interested in hearing how the display affects various members' uses of electricity services such as their cooking and heating routines, and we asked if the display sometimes cause conflict amongst family members. Most of the interviews were audio-recorded and transcribed.

In the UK, we conducted focus group discussions with various people, each representing a household that had received a display in advance. The discussions were facilitated by two researchers and were structured around the same set of guiding questions as the Norwegian interviews, video recorded and transcribed. UK participants who were unable to attend the focus groups received an open-ended questionnaire (following the joint structure).

The various methods have their strengths and weaknesses. The advantage with the in-depth interviews in people's homes was that the display could be observed and formed part of the context in which the conversation took place, which enhanced observation and people's recollection of details in their accounts. Ideally, we would have used the same methods in the two contexts, but focus groups were selected in the UK study due to budget and time limitations. In the focus group settings, each participant represented

their own household, and this seemed to lead them to share their viewpoints relatively freely, for example complaining about co-members' wasteful behaviour. In comparison, eight of the Norwegian interviews were conducted with couples, and in these instances, issues of conflict were more carefully conveyed. Our purpose is not to provide a comparative analysis but rather to qualitatively examine the range of aspects that may come into play during domestication processes. Hence, the use of different methods helped expand the material by providing greater variety in participants' backgrounds and by offering different contexts in which people shared their experiences and opinions. Our aim is to offer a combined analysis of the material from the two distinct contexts. We seek to provide insights into elements of the domestication process: How and why the display was appropriated, where it was located in the home, to what extent the device was compatible with and/or affected everyday routines, the moral economy and the social dynamics of the household, and the symbolic status of the object.

### ***In-depth interviews, Norway***

The ESPARR Norway team included 24 flats in a housing cooperative in Oslo (Røverkollen). By inviting a housing cooperative to participate rather than announcing the trial in the press, we expected that we would avoid recruiting a high share of people with a keen interest in energy and technology and instead include a more general segment of the population (Westskog et al., 2015). The display was of the type Solo II from Green Energy Options (Figure 1). This shows real-time consumption, which the user may choose to have displayed either in technical terms (Watt) or in monetary terms. Actual consumption is also displayed through a speedometer dial with different colours (green, yellow and red) indicating the performance in relation to the set baseline ("fuel gauge"). In addition, the display visualises accumulated consumption through an image of a "fuse" which varies in colour from green (indicating consumption below the norm) to red (above norm). Correspondingly, a "hook" ✓ signals good performance over time while a red cross ✗ tells the user that they have spent more than baseline.



**Figure 1.** Solo II In Home Display, tested by the Norwegian households.

In Norway, the baseline was set during installation by asking for the common amount the household pays for electricity per month, which was typically 50 GBP, but in some cases up to the double, using 75 pence per kWh as the default price. Thus if the display were to show overconsumption, it meant that the families were using more than they had in the past. This baseline can be modified by using the menu on the display. The displays communicate by wireless, but need to be connected to a power outlet; thus they do not run on ordinary batteries. The systems also allow users to access a web-based dashboard platform that is accessible from a computer or smart phone.

Table 1 summarises the profiles of the 24 interviewees. The interviews took place in people's homes in Røverkollen (December 2013-March 2014). With one exception, these households were more financially constrained than what was observed in a co-joint study in Norway of people living in detached houses (Westskog et al., 2015). Thirteen of the households were of Norwegian origin, five originated from Asia, Africa, Latin America or East Europe, while six had a mixed origin (one of the members having immigrated to Norway). Almost all the homes (22) were owner occupied and two were tenants (R7, R21).

### ***Focus groups and questionnaires, County Durham, UK***

The ESPARR UK research studied 23 households in County Durham in North-East England. Each household received an In Home Display of the type SmartEnergy systems (Figure 2) purchased

**Table 1.** Household composition and gender of interviewees, Røverkollen, Oslo.

Household composition	No.	Respondent code
Two or more adults	6	R2, R3, R10, R14, R23, R26
Couple with child(ren)	10	R5, R7, R9, R11, R13, R15, R17, R18, R21, R25
Single parent	4	R1, R4, R8, R12
Single person household	4	R6, R19, R22, R24
Gender of interviewees present during household interviews		
Only women	8	R1, R6, R12, R13, R19, R22, R23, R25
Only men	8	R2, R4, R5, R8, R10, R15, R21, R24
Both women and men	8	R3, R7, R9, R11, R14, R17, R18, R26

from the company AlertMe, which has a display/monitor that communicates real-time energy use and costs and also enables people to view energy consumption as it occurs through the shifting colours on the bar (from green to red as shown in the photo). The system also includes a hub attached to a router, which emits a steady coloured light moving its shading from blue (baseline) through to red (high usage). The baseline was set during installation and represented the average amount of electricity consumed by all SmartEnergy users in the North-East region in the UK. This baseline could only be adjusted through the online facility.

The UK participants in this study were recruited through snowball sampling with members of a local Christian church community to which the research assistant who installed the displays had a personal connection and which facilitated the recruitment process. Three types of households were invited to focus group discussions in

**Figure 2.** SmartEnergy Display kit, tested by UK participants.

which a total of 30 individuals (representing 23 households) participated. One type of household consisted of couples with children, with each couple invited to attend separate all male or all female focus groups, to control for gender variables in the use of IHDs around family activities. The second consisted of retirees, with couples

**Table 2.** Focus group composition and gender of participants, Durham, UK.

Focus group composition and type of household (hh) affiliation	No	Respondent code
A Retired (couples without children in hh)	5	A1, A2, A3, A4, A5
B Family – Male (part of hh with children)	3	B1, B2, B3
C Family – Female (part of hh with children)	7	C1, C2, C3, C4, C5, C6, C7
D Young Professionals (part of hh with several co-habiting adults)	6	D1, D2, D3, D4, D5, D6
E Questionnaire (mix of the above hh types)	9	E1, E2, E3, E4, E5, E6, E7, E8, E9
Gender of participants		
Women	13	A3, A4, C1, C2, C3, C4, C5, C6, C7, D3, D4, E3, E5
Men	17	A1, A2, A5, B1, B2, B3, D1, D2, D5, D6, E1, E2, E4, E6, E7, E8, E9

invited to attend a gender-mixed focus group. The third type of household consisted of single young professionals sharing households, from which the person who acted as our main contact (either female or male) was invited to attend a focus group. Members of any group who were unable to attend the group discussion were invited to fill in an open-ended questionnaire. Twenty-one participants attended a focus group (A-D) while nine people responded to the questionnaire (E), as detailed in Table 2. While the majority of young professionals lived in rented property, most families and all retirees lived in privately owned properties.

### Findings and discussion: Domesticating displays?

The domestication perspective invites important questions about how the display might be approached analytically because of this object's position as a unique though ambiguous type of consumer item. For example, while it might be purchased in the market, its use is also often promulgated by the state (e.g. Norway) or even required by governments (UK) to be offered to all domestic premises, although householders have the right to refuse. Few domestic technologies are thus positioned in the market, the exceptions being perhaps smoke and carbon dioxide alarms that are the subject of government recommendations, and mandatory in some instances. The material presented below will reveal that across the data collected in the two countries, the display presents a general dilemma to participants. As we show, the display spurs or at least intensifies tension by prompting household members to choose whether to think about the level and hence the costs of consumption or to go on living and performing energy-related home practices as usual.

The materiality of displays makes energy use "relational" (Hargreaves et al., 2010: 6115). It can be used *relationally vis-à-vis objects in the household* in terms of initiating comparison between various appliances (ibid.) and between these appliances and the behaviour of human beings:

We have energy efficient appliances, but we hadn't realised still how much energy was used, and the difference between, say, the tumble dryer, the dishwasher, the washing machine, for instance, the shower, again, just came out (B2).

The display is also used to signal changes outside the household: "I always keep an eye on it [the display] from time to time, especially if there are changes in the weather." (R23)

Some of the functions of the displays under study may be modified by users, but few householders had used the opportunity to do so. When asked to assess the design of the displays, most participants said they thought it had an appealing design, though some called for more updated design à la smart phones with touch function. Quite strikingly, very few had taken advantage of the possibility of personalising the baseline, and thus the display's reference for signalling over- and under-consumption. In the UK case this may have been linked to people's reluctance to use the online function, but also in the Norwegian case where the baseline can be adjusted directly by pushing buttons on the display, only three had done so (R9, R13, R24). One of these explained: "We started with 650 kWh and then I had to adjust it up because it is winter, it is colder, and then you must adjust it a little." (R10). Other Norwegian participants acknowledged that the baseline would have to be adjusted regularly to show a realistic picture of performance, but they tended not to do so. In some cases this was clearly related to their lack of knowledge of how to adjust the baseline. But many simply did not seem to have an interest in doing so. In one case, the baseline was set so low that the red light was radiating continuously. When the researcher offered to help adjusting the baseline, the owner said she preferred seeing the red light because it reminded her to be cautious (R13).

We have now highlighted some aspects concerning the display's materiality (designed for self-evaluation and evaluation of co-members, functions not adjusted by users). These are important when we now consider its introduction into our selected households.

### **Appropriating displays**

The appropriation process leading up to an item's acquisition generally involves negotiations and decision making. The process is often described for products offered in the market. The body of empirical literature on appropriation of displays is thin or non-existent, and one important reason for this is that such studies, including the present one, are generally based on trials; thus, little is known about the appropriation of displays in 'real life'. The recruitment strategy through trials is likely to impact the results in important ways. Hargreaves et al. (2010: 6118) refer to the sample they recruited through announcements as 'early adopters'. However, Nyborg (2015: 59-60; drawing on von Hippel, 1986), categorises many of the participants who were recruited to a project testing out smart technology as 'lead users' or 'expert users' in that they were more experienced and interested than the average potential user. Our previous work confirms Nyborg's (2015) findings. In a co-joining project in Norway where participants were recruited through announcements in the press, we found that the participating households were far more interested in energy savings than what is common in Norway (Westskog et al., 2015). Thus, they were not early adopters in the sense that others would be likely to gradually follow their example, but simply particularly interested users. To avoid this problem of bias in the present study, we identified and approached specific communities rather than recruiting participants through open announcements. Linked to the bias of who gets recruited is the issue of who collects the data. As researchers, we often represent and propagate the same sustainability agenda as promoted by policy, and the responses we get are likely to be shaped by people's awareness of the researchers' sustainability bias. This contributes to the "undercurrent of defensiveness" that may run throughout parts of the interviews (Hargreaves et al., 2013: 132) which signals that people feel challenged by the questions asked. When our participants accounted for their interest in joining the trial, their responses should be interpreted with respect to this context of appropriation.

Our interviewees' initial sentiments towards the display were lukewarm. For example, all the male participants in one of the focus groups (family

households) in the UK said that they would not have obtained a monitor had they not been asked to take part in the trial. Apart from a small cohort of users in both countries who said they were interested in technology and initially set themselves sporting challenges to reduce electricity consumption, the interviewees did not appear to have been passionate about the acquisition. The most common reasons given for why people had joined the study included the desire to learn about their own consumption (most common reason in Norway), support research, get the display for free, get the gift card, and, predominantly in the UK, the desire to reduce the cost of electricity (only mentioned by two households in Norway). Participants from the church network in the UK possibly also accepted to join as a friendly gesture to the installer who was part of their community. Overall, the IHD stands out as devoid of the attributes that Pantzar (1997) associates with novel objects of desire. This attitude seems to exclude the IHD as a novelty that has the potential of making a market career on its own, with implications for both policy and commercial actors.

Neither was the display an object that tended to replace the functions of an old product. The exceptions were several interviewees who had grown up in Norway, who thought the display resembled the wattmeter. One person said she had a friend with a wattmeter with whom she exchanges experiences with the display (R26), and five households recalled having used a wattmeter in the past, one of them stating that "... these displays are nothing more than advanced wattmeters" (R25). Other quotes indicate a previous, active engagement with wattmeters:

We used to have one of these [displays], those old wattmeters with those arrows. So I recall ... I have memories, that arrow stands out very clearly to me. Without me understanding completely what it was. But I recall that if we were to bake and turned on the oven and the mix master, you could see it on that arrow. (R10)

It is interesting to learn [from the display] and it stands there and continues to measure in a way... cause I remember that I kept that kind of electricity meter in the kitchen, before, in my old apartment. And it was very interesting to see, like, why it moved, I used it. (R22)

Hence, the wattmeter can be said to form part of a Norwegian collective memory of a former practice of monitoring electricity consumption (see also Westskog and Winther, 2014). This would seem to enhance the appropriation of displays as a functionally and aesthetically “improved” version of a former object, but as of present, the device comes without graded tariffs; thus the incentive for saving money is different from the situation in the past. In the UK three people had had brief encounters with displays similar to the one introduced in the trial, but the devices had been discarded because the potential users had not been satisfied with the performance. In the UK, the signs of previous meaningful use of displays were too scarce to make up a former practice of electricity monitoring.

### ***Positioning the object in the households’ physical environment***

The users’ selection (and potential re-selection) of a location for the monitor is important in representing the significance being assigned to the display in the life of the household. The way displays are positioned in the household’s physical environment may reflect its social and symbolic meanings (Silverstone, 2006: 235), and objects may be used for identity creation (Miller, 1994: 54).

In line with the ascribed purpose of the display, participants in both countries referred to visibility as the key factor when accounting for the choice of location for the monitors. During installation the purpose of the display (to visualise electricity consumption) was explained to them, and they overwhelmingly chose to place it in a room deemed the most frequently and consistently occupied by all members of the household, a feature shared by kitchens and living rooms (cf. Hargreaves et al., 2010). In Norway, it was also relatively common to keep the displays in the hallway. Among the UK participants, most said they preferred the kitchen, because this space was believed to contain the greatest number of appliances likely to affect visible changes to their monitor’s dashboard. However, many were thwarted in obtaining their preferences by the architecture of their household’s electrification, which demonstrates interesting variations that

illustrate the notion of ‘distributed agency’ (Garud and Karnøe, 2005; Wilhite, 2008). The proliferation of appliances on kitchen benches often left no free sockets for powering the display, which requires power from the mains, leaving the living room as the second choice. Available sockets in the kitchen rarely constrained the positioning of the monitor in the Norwegian case. In small, crowded homes selecting necessary surface space for the display could lead to its burial behind clutter or not being put into place at all. One UK participant adapted his home to accommodate the novel object by manufacturing a wall bracket. Others, across the two countries, suggested that a “wall-clock” design, not unlike the old Norwegian wattmeter, would be a practical solution.

However, this fairly general emphasis on a conspicuous positioning for the monitor in line with the object’s inscribed morality did not apply to all participants. Some chose to conceal the IHD because they wanted it out of reach of young children (C6, R15). One woman spirited the monitor away on a shelf in the hallway (R22), and another household stored the display in the laundry room because a female member thought it “looked ugly” (R5). In the UK, one woman withdrew the display from “plain sight”:

... after a while I was getting a bit paranoid about looking at it, and watching what people were using ... I don’t think it’s very good for the rest of the family. (C4)

She believed that if the display were placed in a conspicuous way and if apprehended consistently it would dictate the amount of attention she would pay it. Once the monitor was placed in a drawer, she said, she established control over how often she looked at it. In addition, the hub accompanying the display in the UK, which radiates colours according to performance and which was praised by two people for its simplicity, was typically placed away from the centre of activity, together with their router, sometimes covered in cables or obscured by domestic paraphernalia and discounted as an interactive element in the system:

Yeah. It was in my housemate's room so we covered it up so it wasn't – she couldn't see it because it was in her room and she doesn't want to see that at night. (D4)

These examples reveal how the location and re-location of displays (and the associated hub) in the space of the household reflect negotiations over the item's aesthetical, social and symbolic connotations. Though the urge to hide away the display was relatively uncommon, these cases show instances where users' choices of spatial location went directly against the inscribed call for visibility. In the case where the display was put in the drawer, the householder regained control over the boundary between everyday living and the monitoring of the same, which, as we discuss below, can be considered as a boundary between the private and external domains.

The strength of the "pull" that the monitor exerts, what Hargreaves et al. (2013: 129) refers to as the "nag factor", varied across and within households. When single member households find the monitor troubling they are likely to react by relocating it to a less prominent location, which is a sign that the use of the item in the intended way is rejected. At the same time, the display is protected from social display, which signals the user's refusal to use the display as a signifying object (see below). Both aspects of resistance lead to non-domestication. However, when co-residing individuals relate to the display in distinct ways, this may result in negotiations about where to put it, as reflected in the case where a woman had claimed aesthetic reasons for banishing the display which was then placed out of sight in the laundry room. Furthermore, one UK participant said that despite the display being placed in a conspicuous position, she decided to ignore the monitor because she considered herself to already be parsimonious in her use of electricity.

In households inhabited by more than one person, the IHD invites members to evaluate the performance of each other. Its capacity to document consumption triggered new types of internal monitoring. For example, a young woman in Norway who originated from a third world country shared the following incident, which had led the mother in the house to reproach another

member of the family for her excessive electricity use:

The other day my sister in-law and my sister went into the kitchen and they made cakes and muffins and cupcakes, and, they did this in the middle of the night, right? So when I and mum got up in the morning we noticed that they had used a lot of electricity during the night. (R1).

Complaints about children taking long showers were common in both countries, and in Norway (with electric heating) a common topic of negotiations was the temperature kept in various rooms. Into this picture of ongoing discussions, the display's materiality and way of documenting consumption had a particular effect. For example, among the young professionals in UK who did not constitute families but co-habiting colleagues, the display was often used as an ally to achieve savings by individuals who were particularly concerned about keeping costs down. It appeared that the person attending the trial and focus group would often have this role.

Due to the tension in individuals and between household members between "living as usual" and the "nagging" focus on consumption and costs forwarded by the display, it is not unlikely that the few signs of householders wanting to hide it away might grow over time. However, this does not necessarily mean that interaction with the display will stop because the device may also be placed in a new location and re-domesticated. In a follow-up study of 11 households with displays one year after a first round of interviews, Hargreaves et al. (2013: 128) observed that many of the families had moved the device from its original position to a less conspicuous place. As our study also observed, most people had initially located the display in communal areas of the house such as kitchens, hallways or sitting rooms, but as some residents began to find them intrusive, the monitors were moved to locations such as offices where they were "typically only seen by a single householder" (Hargreaves et al, 2013: 129).

### ***Incorporation of the display in daily life***

The information visualised by the display derives from the householders' uses of light, heaters and appliances, hence the analysis requires attention both to potential shifts in the timing of established electricity practices as well as to when and how the display is perceived and dealt with directly as an object. In the initial phase following installation most families had gone through a testing phase where the display was watched closely as appliances were turned on and off (elaborated in Westskog et al., 2015 for the Norwegian material). People often expressed "surprise" and even "shock" at seeing the consumption of specific appliances, and having this type of knowledge seemed new to many:

Before, we were not aware of the consumption of each appliance. (R3)

It's quite a novelty to start with, seeing what happens when the show is on, when the kettle is on, when the central heating is on etcetera, so that was interesting. (A3)

...it enables me to put my finger on it. (B1)

These surprises had led several households to replace high-consuming items with a less-consuming version of the same items. Additionally, the new knowledge was often said to have led to changes in electricity use, and an interesting difference appears between accounts given in the two countries. Among participants in the UK, the ubiquitous electric kettle had a central position in people's accounts of their modified behaviour. Many reported that due to the display they would only fill the kettle with the amount of boiling water required for the task instead of filling the whole kettle as before. As an exceptional case, one participant said that he had discovered that it was "cheaper to make a cup of tea using the microwave oven rather than the electric kettle" (D6). The man's discovery demonstrates how curious people can undertake experiments with a monitor, but heating water for tea in microwave ovens is unlikely to catch on in the UK. Electric water kettles appear as culturally significant items and their uses are widespread. For example, a recent survey of electricity consumption in 250 homes in the UK

recorded that 99% used an electric kettle (DECC, 2013: 14).

In Norway, electric stoves and heaters were in focus in people's accounts of the adjustments they had made. Nine interviewees gave detailed descriptions of how they had modified their cooking practices and six explained how they had changed heating routines. The changes included turning off the oven or cooking plate before the food was ready to make use of the after-heat, avoiding cooking frequently, lowering indoor temperature and avoid turning the heat on even if it gets colder outside, thus potentially intensifying ongoing discussions about indoor temperature. The focus on cooking and heating in Norway is linked to the considerable amounts of electricity consumed by such appliances, which was discovered by the participating families. A "warm and nice home" is also a cultural value in Norway (Wilhite et al., 1996), but among these flat owners, which were of varied cultural origin, there seemed in many cases to be willingness to negotiate and adjust the temperature.

Both in the UK and Norway, tumble driers, dishwashers, ovens, lights and the consumption of appliances on stand-by were also identified as items that had surprised the households in the amount of electricity they consumed and was said led to adjustments in how they were used. In addition, UK households noted the electricity consumed by electric showers (not used in Norway). Overall, two thirds of the Norwegian flat-owners gave detailed accounts of how they had reduced electricity consumption in one way or another. This self-reported interpretation was confirmed through physical measurements of consumption: In the time after receiving the display (up to one year) they used 12% less electricity than their neighbours, starting from a similar level before introducing the display (Westskog et al., 2015). Similar accounts of modifications in the scheduling and duration of usage were given in the UK, though not physically measured. Sometimes household "necessities" intervened such as reported by the mother of four children who needed to use the tumble drier, but even here the IHD exerted some influence:



Whereas before I might have let it [tumble drier] go for 20 minutes and I'd forget – so sometimes I forget but sometimes the bars will actually remind me “get out there and turn that thing off” so. So it's helping. (C3)

These quotations and the signs of considerable modifications in the timing and duration of electricity use illustrate cases in which the norm of the display appeared to match the moral economy of the household at least temporarily and as assessed by selected individuals. As seen when discussing co-residing householders' conflicting responses to the script (cf. Akrich, 1994) of the display and the way the item was sometimes hidden from sight, a more complex social dynamics came into play. The display was regarded as an ally by those members most concerned with saving on household electricity consumption by providing objective evidence of costs linked to specific practices. In some circumstances reference to the device directly reduced conflict. For example, one couple reflected that the display now made them base their arguments on actual consumption rather than speculations about how much various appliances use (R15). By relating more closely to the cost of electricity, these consumers modified their behaviour towards one another. A man quit cautioning his wife due to the new information:

My wife sometimes washes two towels at the time, which I think is unnecessary. But the display taught me that it does not mean a lot of spending, so I don't make a fuss about it anymore. (R5)

Householders reported that consulting the In Home Display became a new habit in and of itself. Eighteen of the 24 Norwegian households reported looking at the display at least once a day. Four of these participants said that looking at the display became a new habit (R6, R21, R23, R24), one even associating it with addiction: “You get a bit dependent on it.” (R21). Householders also started talking about electricity more often, particularly in the time following installation. Two participants (R7, R9) said that before the display they never talked about electricity in the family. In the UK sample, people expressed similar sentiments, though as noted, in both countries there were a few participants with minor interest in the display.

Many mentioned the display's capacity to remind them to turn off appliances, and a few pointed out that the display helps to reveal unnecessary consumption by other household members.

Although we should be careful about drawing definite conclusions only after three months of use, we suggest that the monitoring of the display, and thus of electricity consumption, emerged as a new routine in many of the households studied. In the case of Norway, the increasing monitoring could mean a revitalisation of a former practice, especially if followed by shifting tariffs, though the distribution of effects may be socially unjust (Westskog et al., 2015). The many accounts of surprises underline the participants' learning outcome, and their interest in the displays seemed to be higher at the time of data collection than what people reported had been the case when joining the trials. For example, very few of the Norwegian households had had expectations for saving electricity before joining the trial, but thought that they had indeed made savings. It is very likely that the frequency of consulting the display may decline over time and that the item may be placed in a less conspicuous site. However, findings from the use of display in the longer term (Hargreaves et al. 2013; Westskog et al., 2015) suggest that people rather modify and re-domesticate the display over time, by finding new spaces for the display, changing the people who regularly interact with it and finding new ways of using it such as when figuring out how to respond to internal or external changes (electricity prices, changing outdoor temperatures), and to monitor “unnecessary” consumption.

### ***Conversion: To what extent do households use displays for stating who they are?***

We now discuss the meanings associated with the display and its degree of compatibility with the moral economy of the households including the identities and values to which they aspire (Silverstone, 1994: 130).

By placing the display in kitchens, living rooms and hallways, the users selected a type of space visible to the judgement of visitors, but because this location is also in adherence with the IHD's script to enhance visibility, it does not necessarily reflect the device's social significance. To

get an indication of the social role of displays we asked participants if they discuss it with the wider family and friends and colleagues. Most Norwegian participants confirmed this and said they had shown it to visitors and received positive responses: The visitors thought “it looked good”, “cool” or “smart”, which is in line with how participants themselves described the design. Two of them had recently hosted parties where the guests had tested the effects of turning appliances on and off: “Everybody thought it was fun” (R23). Except for the few cases where the display was hidden from view, it seemed that Norwegian participants rather enjoyed demonstrating the device to others and that the “smart look” was a central feature in an exchange of meanings (though environmentalism or contribution to research could also have been points of attraction). In the UK, the display appeared to be of less social interest. Some had talked about it with others:

I’ve had people who’ve read about it, and we discuss it, and they automatically go “well yeah, I know I use a lot of electricity” um “maybe I could get one as well, ‘cause it would help me. (B2)

However, none of our UK participants mentioned that the display had been noticed by people outside the household. This variation in the significance of the *social display* of the object may be related to the different designs of displays used in the two countries and/or socio-cultural differences guiding people’s perceptions of displays and how often they receive visitors and so forth. Nonetheless, we deduce that among the Norwegian households, the displays seemed to carry some degree of significance as objects in themselves through social display, reaching a temporary status as a desirable novelty, whereas in the UK such exchange of meaning was less articulated.

Displays may also have a second type of articulation (cf. Silverstone, 1994 and a discussion of television) in that they are not only objects in themselves, but they also convey information about the cost of electricity consumption, and thereby, potentially, invoke associations with the societal costs of production and consumption and associated values held by the householders.

Some participants in the UK were inclined to link using the IHD to environmental values: “We should all be interested in our environment and in our, you know, in what we’re doing to affect that” (C4). Among the Norwegian households, this association was not common, and the difference is probably related to the different sources of production in the two countries where only the British system is perceived to be causing climate emissions. The most common explanation in both countries for the merit of using the display concerned the importance of *having control of expenses and reducing electricity costs*.

We talk about it [the display] every time we talk about finances (R13).

Carbon dioxide. I mean, I’m interested in that. But, to focus me, talk about money (A5).

In addition to financial concerns, people were also sometimes interested in the message the device could convey to children, whom many were keen to recruit into using the monitor:

I think it’s a good thing. Sometimes kids ... if parents haven’t gone on about it, they think it’s free, and they behave like it’s free, like water as well. It’s using resources, not just money. (C5)

The display’s capacity to help householders save money was often mixed with more altruistic motives of “helping the environment”, ensuring that children learn good values and/or a concern to live a prudent lifestyle. Often, participants would cherish the careful resource use that had characterised their own upbringing either in the UK, Norway or elsewhere, and a sense of longing for such values was expressed during the conversations. To households who aspire to live a modest lifestyle and/or uphold environmental values (UK), the IHD may potentially serve as a signifier of such values. However, because a concern for costs was the most pronounced concern (and most interviewees in Norway were relatively constrained financially), the display’s symbolic connotations as a second articulation of values seemed of minor relevance. Lack of financial resources is also likely to be a trait people seek to downplay socially rather than highlight.

In sum, the display had a greater bearing on the households' internal moral economy and social dynamics than it did on upholding values concerning the outside world. Having said that, we find that the display's role as a mediator of the cost of electricity has interesting analytical implications. This information now permeates the home in an explicit and continuous fashion, in contrast to the periodic reckoning of the electricity bill. The message concerning the costs associated with electricity enters the kitchen or living room in a highly visible format, infiltrating personal relationships in ways that prompt squabbles around accusations of carelessness or irresponsibility. Householders interpret and respond to the message conveyed by the display in different ways, and the extent to which the object actually becomes appropriated varies considerably. This is linked to our initial observation that the displays do not constitute desirable novelties, and it helps to account for why the domestication of displays does not follow the same trajectory as ordinary commodities.

## Conclusion

In this paper we have scrutinised dimensions of the domestication process to examine to what extent the display is compatible with households' moral economy. Based on qualitative material collected among flat-owners in Norway and a community in North-East UK we found similarities and differences in the ways people related to the display. Contextual differences account for some of this variation in that fossil fuels constitute a substantial share of electricity production in the UK but not in Norway; thus UK participants were more concerned with environmental issues than were people in Norway. Also, Norwegian households use electricity for space and water heating as well as cooking. Finally, Norwegian electricity prices are highly volatile whereas in the UK they are not. Table 3 summarises some of the central findings from the analysis.

The role played by the display in the examined households served internal purposes more than signalled people's adherence to shared, cultural values. In the UK, the focus on environmental values was apparent, but here the display did not qualify as a physical object for inspection by social others and became an object to talk

**Table 3.** Summary of findings on the domestication of display among Norwegian and UK households.

	Households in Oslo, Norway	Households in North Eastern UK
Previous monitoring practices	Cultural heritage (wattmeters), management of bills	Management of bills
Type of display	Solo II (Green Energy Options)	SmartEnergy systems (AlertMe)
Inscribed norm in display	Visualise electricity consumption	Visualise electricity consumption
Method for data collection	In-depth interviews	Focus groups, questionnaires
Appropriation	"Cold", through trial	"Cold", through trial
Spatial location in household	Kitchen, living rooms, hallways	Kitchen (when possible), living rooms
Temporal integration of display 1-3 months after installation	Consulted daily, triggers internal discussions	Consulted often, triggers internal discussions
Primary focus of participants	Electricity costs	Electricity costs and the environment
Display affecting the scheduling of electricity use	Heating, cooking, light and appliances	Electric showers, light and appliances
Conversion, the object itself	Socially significant, "smart"	Socially insignificant
Conversion, second articulation	Signal modest consumption	Signal frugality and environmental values

about rather than demonstrate. In the Norwegian sample, the reception of the display was more enthusiastic and included social display, but here the families' financial constraints, which is likely to carry social stigma and therefore downplayed, made the display appear as an internal matter for the household. The compatibility of displays with the household moral economy was therefore strong in the group in Norway, as it helped them gain control of their finances. Among UK households, the significance of keeping costs down was less articulated, though this might have been connected to participants' hesitations to share sensitive information during focus groups. However, the "loyal" positioning of the display in communal areas in the household (at least until the meeting with the researchers were completed) indicates a picture of some degree of compatibility in both countries.

The material from both contexts demonstrated the way the display triggered various types of social dynamics. This is because the feedback provided through displays competes with other kinds of feedback (Strengers, 2013). As householders are performing meaningful home practices associated with comfort, cleanliness and convenience (Shove, 2003) the display brings attention to electricity in monetary terms, often in disturbing ways. The display constitutes a forced reminder that electricity is (also) a commodity and invites householders to judge the performance of each other. The display can generate friction within households as some members deploy it as an apparently neutral "ally" to justify nagging others. At the heart of the tensions are some members' reluctance to want to know how much electricity was actually consumed. However, the device soothed friction when it served to correct erroneous assumptions, as in the case of the husband who previously berated his wife's laundry practices.

A key question we wanted to address was whether the IHD triggered a new practice of monitoring electricity consumption. Ahead of the display people had been used to servicing the bill, which provided rare moments when their level of consumption came into focus. Many of our Norwegian households noted the display's resemblance to a former mandatory object (wattmeter) which potentially could be revoked, whereas in the UK the IHD has appeared relatively recently. Among both groups, however, many participants gave detailed accounts of how they monitored the IHDs. The regular consulting of displays, some people's reference to their "new habit", and the new and more frequent talks about electricity led us to suggest that monitoring electricity became a new routine for many of the participating households. This conclusion was strengthened by the observation the Norwegian flat-owners continued to use less electricity than their neighbours up to one year following installation. However, people's accounts were collected only three months after installation, and a conclusion on this point should ideally be qualified by examining people's experiences and assessments of the IHDs in the long term. In order for monitoring through displays to qualify as an emerging social practice, it would require a higher degree of consensus among householders than observed, in terms of perceiving and experiencing monitoring as a socially meaningful practice.

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## Notes

- 1 Pantzar (1997), Silverstone (1994) and Lie and Sørensen (1996) all refer to domestication as the 'taming' of objects as these enter private homes and become part of everyday life. They have analysed the phenomenon on various scales and for various technologies. Pantzar (1997) focuses on the level of practice, examining how the social significance of objects changes over time. Silverstone (1994) and Lie and Sørensen (1996) focus on the diffusion and domestication of technologies.
- 2 In the present work, we focus only on how the inscribed norms appear and to what extent they continue to yield relevance on the user side. We do not treat the initial stage of development when they were shaped in accordance with designers' ideas about potential future users (see Hyysalo, 2006, 2010 on 'practice-bound imaginaries').
- 3 In a discussion of appropriation, Silverstone (1994: 130) denotes people's display of objects as indications of their "membership and competence in a public culture." In the present work we refer to cultural values following Gullestad (1992: 21) as "categories which are used to justify [e.g. action] without themselves needing justification".
- 4 In a more recent publication, Silverstone (2006: 233) denoted this step 'commodification'.
- 5 We here follow the domestication tradition (Silverstone, 1994, 2006) by emphasising the spatial dimension embedded in the notion 'objectification'. Earlier authors from the material culture tradition have employed 'objectification' to denote objects' symbolic and social meaning (e.g. mirroring identity), as outlined by Bourdieu (1977), Douglas (1982) and Miller (1994, 1998), thus resembling the step of 'conversion' in the domestication process.



# The Physiology of Imagined Publics: From a Deficit to an Ambivalence Model

Gisle Solbu

Norwegian University of Science and Technology, Norway/gisle.solbu@ntnu.no

## Abstract

This paper draws on the concept of imagined lay persons (ILP) to investigate how scientists working in the fields of bio- and nanotechnology perceive the public and how these imaginaries facilitate or hinder engagement activities. Based on 37 in-depth interviews with bio- and nanotechnology scientists, I explore how scientists construct imaginaries of publics that may shape the ways in which they address the public, perceive the benefits of public engagement activities, and form communication strategies. The paper argues that scientists' accounts of the public are characterised by ambivalence regarding what the public is, the public's knowledge and the public's ability to take part in scientific processes. Thus, the paper proposes a more comprehensive approach to understanding ILPs than provided by previous studies, which have focused on the attribution of knowledge deficits and related fears of protest and resistance.

**Keywords:** imagined lay persons, deficit-model, public engagement

## Introduction

Since the early 2000s, developments in European science policy discourses have shown increasing attention paid to science society issues. For example, the recent Framework Programmes have addressed such concerns. In Horizon 2020, this is articulated through the concept of Responsible Research and Innovation (RRI), which has become a major cross-cutting issue (see Felt et al., 2013; Felt and Wynne, 2007; Owen, Macnaghten and Stilgoe, 2012; Siune and Markus, 2009; Stilgoe, Owen and Macnaghten, 2013; Von Schomberg, 2011, 2013). This development in science policy discourse is not just talk. With the implementation of RRI as a main normative element in science governance, substantial interventions are expected in

established research practice. To receive funding from Horizon 2020, all projects must, in principle, consider measures to involve societal actors in the research design and reflect on the potential implications of the project outcomes, in order to make science better aligned with the 'values, needs and expectations of society' (European Commission, 2016).

Thus, scientists are increasingly expected to incorporate public engagement and participatory activities in their research. This raises interesting questions regarding how scientists understand and interpret this requirement, including how they perceive the public and the public's capacity to engage with science. Such knowledge is

needed to assess the viability of RRI. To help fill this knowledge gap, this paper introduces and applies new perspectives on the way in which scientists think about the public and public engagement in science.

Previous studies have shown that scientists tend to employ what is commonly described as a 'deficit model' in their accounts of the public's perception of science (Barnett et al., 2012; Besley and Nisbet, 2013; Heidenreich, 2015; Maranta et al., 2003; Walker et al., 2010). This deficit model is primarily a concept that signifies the widespread assumption of an epistemic divide between those who know – scientists – and those who do not – lay persons (Maranta et al., 2003). Thus, the public is seen to lack scientific literacy, and this knowledge deficit is considered the source of irrational and sceptical attitudes towards science and new technologies (Bauer, 2009). While the deficit model has been shown to produce a misunderstanding of the public's relation to science and scientific expertise, studies suggest that this way of thinking is widespread among scientists (Irwin and Michael, 2003; Irwin and Wynne, 1996; Wynne, 1992, 1995). This paper questions the role of the deficit model in scientists' accounts of the public and suggests a more diverse and complex understanding of them.

In the following, when analysing scientist's accounts of the public, I will focus on two main issues. The first is what 'knowledge' means in the context of scientists' ideas about the public's relation to science. Bruno Latour's (2004, 2008) distinction between 'matters of fact' and 'matters of concern' may be invoked to suggest what is at stake here. The concept of 'scientific literacy' – often referred to in relation to the deficit model – usually focuses on the need to understand matters of fact, such as elements of physics or chemistry (Bucchi, 1998). We should ask: to what extent are scientists concerned with scientific literacy, compared to wider aspects of science, such as values and impacts? The second issue is what 'participation' means in the context of scientists' ideas about the public's relation to science. The tenets of RRI push for an early integration of a wide range of societal actors into the research process. Previous research has shown that due to a deficit model understanding of the public's

understanding of science, scientific institutions are reluctant to involve the public in scientific processes beyond communication activities and open up the research to public dialogue and deliberation (Marris, 2015: 85). Thus, it is pertinent to ask how scientists understand participation.

This paper investigates these two questions by exploring scientists' accounts of their research practices within the fields of bio- and nanotechnology in Norway. In the Norwegian context, bio- and nanotechnology are two fields that are of a special interest regarding science and society relations. Both bio- and nanotechnology are considered new enabling technologies. Consequently, they are ascribed great transformative powers and given an important role when articulating Norwegian sociotechnical imaginaries (Kjølberg, 2014). Because of this imagined transformative potential, these two fields have also gotten special attention from the Research Council of Norway regarding ethical, legal and social aspects (Nydal et al., 2016).

Through 37 in-depth interviews with scientists working within these fields in Norway, this paper studies the way in which scientists understand and construct images of the public. It analyses the main discursive dynamics in the scientists' imaginaries of the public, providing a more complex understanding that goes beyond the features of the deficit model. To clarify the theoretical point of departure, I introduce a more detailed analytical framework and explain more thoroughly the concept of 'imagined lay persons' (hereafter ILP) (Maranta et al., 2003).

### **Exploring imaginations – the public as a phantom**

This paper's approach to the study of the science society relation is indirect. It does not study the public as a group of physical actors in concrete engagement activities, but turns the attention to scientists' imaginations of the public. Already in the pragmatist thinker Walter Lippman's (1925) work of the 1920s, we find a description of the public that focuses on aspects of imagination instead of physical appearance and utterances. He introduces the metaphor of the phantom, which has been used by Bruno Latour (2005) and Noortje

Marres (2005, 2007) to show the diverse ways through which the public is present in democratic institutions. Marres describes the 'ungraspability' and vagueness of the public as important characteristics of the public's agency. In her own words:

In this way we may appreciate that ungraspability may be an aspect of agency and also that the agency of rather ungraspable entities may make things happen that wouldn't otherwise. We then say that what makes a public such a special agent is that when specific actors get organized into one, they may evoke the anonymous, collective, virtual, somewhat mysterious creature we call public. And maybe it is precisely in this capacity of a phantom that a public may generate that virtual, somewhat mysterious thing called 'pressure', which can then be directed at specific instances, to induce shifts in their habits, policies, regulations, commitments (Marres, 2005: 216).

Recognition that the public display such phantom qualities is important for my study in two ways. First, it means that we should acknowledge that the public always is present in some way – at least in an abstract sense. Accordingly, scientists have to position themselves in relation to the idea of the public, even when they are not directly involved in public engagement activities. Second, the recognition suggests the need to explore these imaginations of the public in order to understand how these imaginations may shape science society relations. Considering that the public exists in this mode of ungraspability has made others, such as Gottweis, Chen and Starkbaum (2011), pursue the task of giving flesh to the phantom. However, this paper's approach is different. It makes no effort to uncover the phantom, but explores the public, as it exists in the mode of the ghostly and omnipresent; as a mental construct of scientists.

While the metaphor of the phantom suggests that the public is vague and difficult to explicate – almost mystical – the concept of ILPs introduced by Maranta and colleagues (2003), aims at grasping and conceptualising the way in which these imaginaries inhabit and influence scientific practice. With the concept of ILPs, they present a main argument similar to Lippmann's. The public is not just taking part in and influencing scientific practice when they are engaged directly, like

being consulted, invited to dialogue meetings or through participation in democratic decisions. The public also influences scientific practice, like through public pressure on specific lines of research, as an abstraction and mental construct of scientists (Marres, 2005).

In this paper, I employ the concept of ILPs to explore the practices of scientists. To do so, I link the concept to previous efforts to study technology and its users, and the way in which these users, consumers and the public influence the development of new technology. For example, Akrich (1995) and Woolgar (1990) studied how designers of new technologies imagine potential users and how they will make sense of and use their designs, applying these imaginaries when constructing or configuring new artefacts. In this manner, these studies show that the process of developing new technology is one in which future users and their use are constructed (Walker et al., 2010: 933). In this sense, technologies are always constructed from assumptions about future users and use, even if these assumptions turn out to be incorrect (Lie and Sørensen, 1996). In this sense, the public takes part in shaping technology (Bijker, 1995; Bijker and Law, 1992; Woolgar, 1990)

While Akrich and Woolgar studied technologies with a specific and targeted public, scientists' attentiveness towards the public may not be obvious with respect to basic research. However, Maranta and colleagues (2003) extend the argument of the public's influence from the explicit and physical to the abstract and imagined. This makes for an interesting progression of thought that ties the concept of ILPs to the study of imaginaries and their performativity. The latter field of study shares a focus on the performativity of discursive constructs. They may be collective visions, established and maintained in society in the broader sense and captured by concepts such as 'sociotechnical imaginaries' and 'folk theories' (Jasanoff and Kim, 2009; Rip, 2006) or strategies and objectives on a micro level, like those investigated through the sociology of expectations (Borup et al., 2006; van Lente, 2012). The main argument, also found in Maranta et al. (2003), is that discursive constructs, like imaginations and previous experience of actors and expectations of how they will behave, shape behaviour.

Still, previous studies of ILPs have focused mainly on fields of expertise that seemingly directly have implicated the public. Maranta and colleagues (2003) explored experts working in science centres, public consultations within environmental studies, and experts engaged in GMO regulation and labeling. In each of these case studies, orientation towards a particular public was prominent. In a similar manner, ILPs have been explored with regard to public acceptance of renewable energy technologies; for example, in studies of scientists' imaginations of the public attitude towards offshore windmills and the influence of this perception on decision-making (Burningham et al., 2015; Heidenreich, 2015; Walker et al., 2010). This body of work has shown that ILPs can fulfill a functional purpose in the interaction between different knowledge communities (Maranta et al., 2003: 150). ILPs have been shown to influence the way in which scientists address and communicate with the 'real' public as well as the issues that receive research attention. These studies have highlighted differences in capabilities in the expert public relationship. While these studies offer valuable insight into scientists' imaginations of the public on specific scientific issues and their imagined differences between experts and laypersons, we need a more comprehensive approach.

In this regard, the work of Sara Heidenreich (2015) may serve as a stepping-stone. While she, like previous studies, identified a deficit model in scientists' accounts of the public, her findings expose ambiguity regarding the extent to which this imagined knowledge deficit actually was a concern. Actually, the dominant narrative of the interviewed scientists was about a positive public. However, there was also a continued presence of narratives of irrational public resistance, based on a kind of cultural pessimism. Furthermore, Heidenreich (2015) observed a disembedding of the technology under development, which rendered public engagement less relevant.

This paper follows Heidenreich's lead, but further questions common assumptions about the appropriateness of the deficit model as way of making sense of scientists' accounts of the public and what these accounts suggest regarding the shaping of research and innovation. This means

to go beyond the belief that such influence is the result of a physical presence, for example, when public engagement activities are implemented in research projects. First, the paper analyses the public's role in scientists' work as "conceptions of lay persons as they are manifested in the products and actions" (Maranta et al., 2003: 151) of our interviewees. What is the content of these imaginaries? Second, it studies what it means to argue that these mental constructs should be considered "just as much an artefact of the knowledge production as is the more technical part of the solution proposed" (Maranta et al., 2003: 151). Third, previous studies of ILPs have shown that scientists tend to employ a deficit model in their accounts of the public. Following Latour's (2004, 2008) clue regarding the distinction between what he calls matters of fact and matters of concern, this paper explores the gains of transcending the common focus on knowledge primarily as scientific literacy. Are there other accounts of knowledge and participation that shape scientists' interpretations of the public's understanding of science and the public's ability to take part in research processes?

## Methodology

The three above-mentioned research questions are pursued drawing on semi-structured in-depth interviews with 37 scientists. The interviewees were selected to cover five field sites within what can broadly be defined as nanotechnology and biotechnology: 1) nanomedicine (five interviewees), 2) genetic medicine (nine interviewees), 3) synthetic biology (seven interviewees), 4) nanomaterials in energy research (seven interviewees) and 5) other fields (nine interviewees). The fifth field site was labelled 'other' because those interviewees worked on projects topics that clearly were related to either bio- or nanotechnology, but did not quite fit into the other four field sites nor constituted another well-defined category. Within the five sites, interviewees were chosen to cover a range of academic positions, varying from PhD research fellows to senior scientists, research group managers, and professors. All were working in Norway, at a university, a private research institute or a biotech or nanotech start-up company.

**Table 1.** Interviewees categorised by field site, interview number, academic position and gender.

Field site	Interview nr.	Academic position	Gender
Nano-medicine	NMIW3	Professor	Man
	NMIW6	Professor	Woman
	NMIW13	Post-Doc	Man
	NMIW19	PhD research fellow	Man
	NMIW22	Researcher	Woman
Genetic medicine	GMIW10	Professor	Man
	GMIW15	Professor	Man
	GMIW16	Professor	Woman
	GMIW17	Professor	Man
	GMIW18	PhD research fellow	Woman
	GMIW28	Professor	Man
	GMIW30	Professor	Man
	GMIW36	Professor	Man
GMIW37	Professor	Man	
Synthetic biology	SBIW7	Professor	Man
	SBIW8	Associate professor	Man
	SBIW12	Researcher	Man
	SBIW20	Professor	Man
	SBIW26	Researcher	Woman
	SBIW31	Associate professor	Man
	SBIW32	Associate professor	Man
Nano-materials in energy	NEIW2	PhD research fellow	Woman
	NEIW4	PhD research fellow	Woman
	NEIW5	Researcher	Man
	NEIW24	Professor	Man
	NEIW25	Post Doc	Man
	NEIW34	Professor	Man
	NEIW35	Researcher	Man
Other fields	OFIW1	Professor	Man
	OFIW9	PhD research fellow	Man
	OFIW11	Professor	Woman
	OFIW14	Professor	Woman
	OFIW21	Researcher	Man
	OFIW23	Professor	Woman
	OFIW27	Post Doc	Man
	OFIW29	Researcher	Woman
	OFIW33	Professor	Man

Table 1 shows the selection of interviewees categorized by interview number, field site, academic position and gender.

All of the interviews were conducted individually and lasted 40 to 110 minutes, most lasting just over 60 minutes. 25 interviews were undertaken by Dr. Heidrun Åm and the author together, Dr. Åm did four interviews singlehandedly, while the author did eight. The interviews were conducted as part of the project "Performing ELSA - Governance of and governmentality in biotechnology and nanotechnology research", with Dr. Åm as

project manager. However, the analysis has been conducted by the author.

The interviews took place at a location chosen by the interviewees. All but one gave permission to audio record the interview. In the case where permission was not given, the interviewers took written notes during the interview and wrote a rich synopsis immediately afterwards. The recorded interviews were transcribed and all interviewees were made anonymous. Then, we categorised them according to their respective field sites and provided an identification consisting of a unique

number and two-letter abbreviation to identify their field site. Nano medicine was shortened to NM, genetic medicine to GM, synthetic biology to SB, nanomaterials in energy research to NE, and other fields to OF.

A central feature of the research design was that the topics we explored during the interviews were aimed to uncover the scientists' perception of the public and public engagement activities. In addition, we also inquired about how the scientists situated their research within a societal context and about what they experienced to be ethical, legal and social aspects of their work. In this way, the interviews generated accounts of the public that related to the scientists' scientific work in specific and the public's scientific literacy. They also provided views regarding the public's participation in science within a broader context and related to a more comprehensive understanding of knowledge than just scientific literacy.

I have analysed the data in three stages, inspired by an abduction-oriented form of grounded theory (Charmaz, 2006; Reicherz, 2007). This means that the analysis drew on the theoretical approach described in the previous section, which played an important part in structuring the interview guide, but also that empirically grounded concepts were developed continuously from the interview data. The choice of a grounded theory inspired methodology was based on the explorative nature of this analytical approach, and the wish to develop novel theoretical insights that was grounded in the empirical material. However, the approach also has its limitations. Grounded Theory inspired approaches have been argued to obscure the researcher's embeddedness and agency in the data interpretation. It was thus important to create awareness, and reflect upon my own position as a researcher during the analysis (Olesen, 2007). This was stimulated through the discussion with my collaborators in the project.

The initial stage of the analysis involved thematic coding of the transcriptions to identify statements and arguments that were relevant to the topic of imagined publics. This coding was conducted using the qualitative analysis software Atlas.ti. Following the coding, summaries of each interview were written, including all relevant

quotes from the transcripts. While the interviewees had been selected to cover the five previously mentioned field sites, this initial stage of the analysis clearly showed that there were no remarkable differences between the groups. Thus, after this stage the interviewees were treated as one group in the analysis. In the next stage, a second round of coding was carried out in Atlas.ti; this coding was restricted to the interview summaries and paid greater attention to details in order to further explicate the findings of the initial round of coding. This final set of codes formed the basis of a matrix of all 37 interviewees, in which they were grouped according to their respective field sites. Then, each individual was linked to relevant information based on the interview transcripts. This systematisation helped identifying patterns of similarity and difference across statements and arguments, both within and between field sites. In the third and final stage, a final investigation of the full transcripts was conducted to contextualise and further enrich the preliminary findings.

## The physiology of ILPs

How did the scientists imagine the public? In the following analysis, the concept of physiology is used as a structuring device. Within biology, a schoolbook definition of physiology refers to the dynamic and organic processes that take place within an organism (Physiology, 2014). Here, the organism studied was the ILPs, and their physiology includes the main discursive dynamics that the interviewees used in their accounts of the public. The use of the concept of physiology is with this respect intended to underpin the dynamic and procedural character of the ILPs' constituents. The term 'main discursive dynamics' refers to the recurrent core themes that the interviewees talked about when they were inquired about their views of the public. In the ILP physiology as it emerged from the analysis, I identified three main discursive dynamics: (1) knowing, (2) trusting, and (3) enabling. In the following, I elaborate in turn on these three dynamics.

### ***Dynamic 1: Knowing***

In line with previous research (Barnett et al., 2012; Heidenreich, 2015; Walker et al., 2010), (not) *know-*

ing was identified as one of the main dynamics in the interviewees' constructions of the public. This was considered a key aspect in shaping public attitudes. In other words, the interviewees' imaginations of the public's knowing partly overlap with the previously highlighted deficit model. The following example provides an illustration of this. One of the interviewees made a direct link between the public's low level of knowledge regarding his field of research and the public reluctance towards the new technologies he was developing and using to do genetic research. He had experienced the public to be sceptical towards the use of genetic modification techniques. In the interview, he talked about the difference between old methods of genetically enhancing agricultural products, and what was now possible through new techniques of genome editing. He also expressed his belief that if the public only knew about the advantages of this new technology, they would be positive:

We actually do the same. We don't use radiation but we introduce exactly the same mutations but we do it selectively, so in this way I think if people become aware of that difference it could be that they after a while will change their attitude, but I think we have a long way to go. (SBIW32)

This line of argument was echoed among other interviewees who similarly experienced some degree of reluctance towards their work. If the public had sufficient knowledge, they would change their attitude. While scientific literacy was discussed as a key aspect in shaping attitudes – something that could suggest the need to initiate public educational campaigns – the scientists were still, in general, quite relaxed about this lack of knowledge. Their imagination of the public's inability to understand complex scientific matters seemed to curb pro-active communication strategies and efforts to inform the public about their research. An interviewee who was involved in a basic science project with the objective of developing new nanomaterials for fuel cells explained:

One of the most difficult things we do is to explain things so that the world out there understands it, without lying I mean, without exaggerating, so [...]. We have to simplify it to such a degree that it usually becomes pointless to describe it, but

anyway, we have to do it. As an example, I now work with fuel cells, but that is not the fuel cells that will be used in actual cars, but I have to jump that stage, because it is not in the interest of the general public to know. I work with fuel cells, and those cars will get here, that is how simple we put it. (NEIW34)

As this quote highlights, there is an obvious and expected epistemic gap between the knowledge of the expert and that of the lay public regarding scientific matters. However, it is important to stress that often, the scientists did not believe that this gap could be bridged. Rather, the scientists emphasised the difficulty in bridging it, as in the following quote. Here, a scientist working within molecular biology talks about how specialised her field is, and what is required to develop scientific skills.

GMIW23: [...] it is so specialised, that we know almost nothing about each other's fields, like... we have some general knowledge, but when it comes to the specific topics, it is very specialised.

Interviewer: Do you think the public should know more?

GMIW23: That is impossible because it is necessary to have five to six years of education to learn this, so that is not something you can expect. (GMIW23)

Thus, while the public's knowing – in terms of scientific literacy – was imagined to involve misconceptions and in some instances to cause reluctance towards new technologies, this knowledge deficit was not a major concern for the scientists.

While a knowledge deficit often was recognised when it came to scientific matters, this was not the only kind of knowledge that concerned the scientists in their imagination of the public. The scientists were also interested in how the public understood science as part of social development in general. For example, this was articulated by one of the interviewees when he explained why it was important for science to receive positive and contextualised media coverage:

I think that it [positive media coverage] is very beneficial, because then the public is able to understand the benefits and understand that we try to solve big social challenges that lie ahead of us. (NEIW24)

In this regard, the fact that interviewees point to the public's understanding of the social context of science, questions the role of the deficit model in scientists' accounts of the public's understanding of science. Foremost, previous studies of ILPs have paid attention to how public knowledge, understood as scientific literacy, was imagined. In our interviews, we found in addition that a more general kind of knowledge was made essential in the scientists' accounts. This knowledge was about the social context of science, including wider aspects, such as science's impact on social development and values.

This is related to but not identical with what Latour (2004, 2008) calls matters of concern, because it refers to processes as well as the content of a particular way of public understanding of science. I propose the concept of 'epi-knowing' to characterise such knowledge and the process of gaining knowledge about matters of concern. The prefix 'epi' is here derived from the Greek preposition ἐπι, meaning 'nearby'. Regarding the scientists' accounts of the public, just like circles around an epi-centre, epi-knowing is the knowledge and competence that the scientists ascribed to the public regarding matters of concern; that is, in relation to more general issues that are situated outside the core scientific tasks of their daily practice.

The scientists' differentiation between the two kinds of knowing also meant that their beliefs about the public's attitudes and abilities varied according to the kind of knowing they were talking about. When it came to epi-knowing, the scientists' attitudes regarding the public often changed from exclusion to inclusion. With respect to such concerns, their imagined public had or could acquire relevant knowledge and competence. In this regard, the public's knowledge directly or indirectly was considered to influence the development of science through the priorities of political institutions and funding agencies. One of our interviewees talked about how he felt that institutions such as the Research Council of Norway were good at deciding what kind of research that would benefit Norwegian society. Thus, he felt that the direction of science should be a political decision:

Like, overall, I guess the research council in Norway in a good way directs research that is useful for society. If you look at their programmes, they seem to be very relevant for the future, and what happens, and what could be problems that are arising in the future. (SBIW8)

Many of the scientists – while protective and excluding with regard to their own work – still imagined that the public played a part in the development of science at a general level. Further, they imagined that the public's epi-knowing shaped research priorities. This expressed a change of subject position for the scientists, compared to their subject position when imagining the public knowledge in terms of scientific literacy. Talking about scientific literacy, the scientists established a gap between themselves and the lay public, excluding the public from scientific procedures. However, when talking about issues of epi-knowing, the scientists actually situated themselves within the public, sharing social concerns and responsibility for scientific developments:

I think that everybody who works with molecular biology, and also molecular medicine like we call it, are like every other human being. We are often husbands or wives, and often have children and we live in society. I am not a molecular biologist, like, I am a human being that works with molecular biology [...] Of course you take part in society in the same way as everybody else, and not like an eremite. Me too, I want society to develop in a direction which is to the best for its citizens. (GMIW10)

To summarise, in the analysis of the interviews, I identified an imagination of the public that fitted well with the deficit model, wherein attitudes are linked to the level of scientific knowledge and scientists establish a gap between themselves and the public. However, another kind of knowing also emerged from the analysis of the scientists' account of the public. When scientists talked about what I call epi-knowing, the understanding of the social context of science, they created a common ground between themselves and lay people. Moreover, they imagined the public epi-knowing as a legitimate contribution within the broader scientific domain.



### **Dynamic 2: Enabling**

The scientists' distinction between knowing and epi-knowing also influenced their imagination of the public's agency – that is, the public's ability to take part in and shape scientific trajectories. This is what I call the imagined *enabling* of the public. In this regard, the scientists made important distinctions between certain aspects of scientific conduct. When talking about how they imagined the public to take part in and contribute to research, the scientists ascribed varying degrees of agency depending on whether they were talking about their own specific research projects or the general development of science.

With respect to their own projects, very few of the scientists had any concrete experience in engaging with the public, and many argued that the public's ability to contribute to their work was very limited. In contrast to a main tenet of RRI, they could not understand how lay people could contribute to projects that required a high degree of expert knowledge:

It's just talk [the policy of public participation]. It's just [...] totally pointless, right? But, we very much want to open up our research in the sense that we want to explain what we do and why we do it, and the patients love us, so that is a very enjoyable task. But, that the patient should influence our research to make it better? They don't understand what we do, right? [...] I can't imagine what they could contribute that would make us better at doing science, that I just have to say. It's perhaps a bit arrogant. (GMIW)

It is important to stress that often, the scientists' experienced their own agency also to be low. Especially those working within basic research described the scientific endeavour as unpredictable and difficult to direct towards a specific objective. The scientists worked within long timeframes. They were engaged in developing new knowledge that they did not expect to have any impact for maybe 20 to 30 years. Further, the interviewed scientists had difficulty specifying exactly what kind of impact this would be. Those doing basic research found it difficult to locate any legitimate space for lay involvement or engagement. They claimed actual scientific work was the only thing that could affect science in such early

stages. One scientist, working in the field of synthetic biology, specialising in mutations in bacterial DNA, explained this position as follows:

I have a problem understanding the things that I do and I don't expect, I mean WHO should come and tell me what to do while I have trouble understanding how these things operate [...]. The things that we do, are [...] not direct consequences of logical thinking. There is a lot of things that you just stumble across [...] and this is due to intensive work [...]. You never know what the outcome will be. (SBIW12)

Such imagination of agency, 'the slight surprise of action' (Latour, 1999: 266), in basic research seems to exclude the lay public. However, just as we saw that there were two different ways of understanding knowledge in the scientists' accounts of the public, they also displayed different ways of understanding agency. Their imagined public was considered able to contribute to the research process when they could be addressed as experts who could contribute specific knowledge, such as information about being a patient. Most important, the public was imagined to have a strong influence on the general development of science, due to their epi-knowing regarding science. When asked about how they imagined the public to contribute to their work, many scientists spoke about indirect participation, claiming that the public was already involved in discussions about science, at a general level:

We do that [include the public] ... but it's just that it's with respect to political decisions, it is the political parties that have the power and that people vote for. (NEIW24)

The interviewed scientists experienced their own research largely to be directed by research programmes and political decisions. In this way, they emphasised that society ultimately was 'the boss' (SBIW8). If the public was not considered part of the scientific process, per se, it was represented through the work of political institutions and funding agencies. One scientist, working on a basic research project to which she could not imagine any contribution of lay knowledge, stressed that the fact that this indirect participa-

tion existed was important to legitimise why they did not engage directly with the public. Accordingly, she explained that her supervisor had argued that “the public’s needs, indirectly, are taken care of by the EU and the requirements of the research council [of Norway], that is supposed to be for the best of society” (NEIW4). However, the scientists did not reflect upon any limits to decision-making representative democratic processes may have when it came to dealing with complex socio-technical issues.

To summarise, when it came to actual scientific work, the public was imagined to have a low level of agency. The public was only imagined to be useful and contributory in relation to technologies that were close to application (about which the public could be consulted as users and consumers) or in medical research projects (wherein the public could be consulted as ‘experts’ on being a patient). However, the interviewed scientists thought that the public had a strong influence on the development of science through indirect participation as such as citizens electing politicians.

### **Dynamic 3: Trusting**

The third and final main dynamic identified in the scientists’ ILPs was *trusting*. For those working in fields that were somewhat controversial, such as genetic medicine, public misconception of their work was a real concern. One scientist working with DNA sequencing was nervous that lack of trust and misconception among the public could result in limitations on her own research. She argued that it was difficult for scientists to gain an authoritative voice in the public debate, and felt that research and development always were in danger of being misinterpreted. In the interview, she elaborated this point by explaining why she had been anxious before an interview with a national newspaper about a major breakthrough in her research:

This technology [DNA sequencing] has (...) sometimes been given a very negative spin because it is the same technology that they use to check for, that you now can use to check the embryo if a child will develop Down’s syndrome or not. So you can use it as an example in the debate about aborting embryos that will develop

such diseases, and many of these kinds of negative debates, so everything has been mixed up together to a mishmash of a debate. And we who are engaged in this we just stand here and are frustrated, because everything is mixed up. (GMIW18)

Her imagined lack of trust in her scientific authority among the public made this interviewee attentive towards the communication of her work. She perceived the public as an obstacle because of the concern that possible misinterpretation could give her work a negative spin. The resulting public reluctance and mistrust could, she feared, lead to new regulations:

If this technology had gotten very negative coverage, only negative coverage, then in worst case scenario [...] it won’t happen, but it could have been made illegal. (GMIW18)

Interviewees working within fields experienced as controversial were concerned in similar ways about public misinterpretation and mistrust. However, the dominant account was of a public that was trusting. The majority of the interviewees imagined a public that supported their work as scientists and believed that the public believed science contributed to solving social challenges. This perception of a trusting public is supported by a 2010 Eurobarometer survey on biotechnology that shows a very high degree of trust in scientists and university employees among Norwegian citizens (European Commission, 2010).

The belief in a supporting and trusting public was especially common among the interviewed scientists working with medical research. When asked about how she believed the public perceived her work, a scientist who had developed a new nano medical device answered as follows:

I’ve not met anybody that has been critical towards it [my research], not a single person, and I’m actually a bit surprised by that because I’d actually thought that I should meet more [critical attitudes]. But everybody’s really like, yes, continue with it, work with cancer research, do anything you want, just solve it. (NMIW22)

This quote illustrates a recurring narrative in the interviews: society is faced with a problem that science must try to solve, and in this process of problem-solving, scientists are trusted to do their best. Furthermore, in the accounts of trusting, scientific literacy was seldom a central element. Rather, the interviewees believed that the crucial issue was a shared interest in the outcome of scientific efforts. One scientist, who developed personalised cancer treatments, told that he was dependent on using biological material from cancer patients in his research. He explained that almost everyone agreed to participate in his studies, but he did not believe that they fully understood what they were agreeing to. The science was complex and difficult to explain, but the patients were often in a vulnerable position. He thought they agreed because they wanted research on their disease to progress, and they trusted the scientists to do their best:

So I think most of them give their consent on a weak foundation. It's just a declaration of trust, end of story. They say that it's great, "I'm so happy that you are treating me, please, do research on my samples, it's all fine." (GMIW30)

A trusting public was considered important for recruiting participants to research, but it was also presented as a core motivation for doing science. The scientists explained that their experience of a public that trusted in science and believed in its usefulness made their scientific work meaningful.

To summarise, the dynamic of trusting was crucial in the scientists' accounts of the public. Some scientists worried that misinterpretation of their research could cause scepticism and mistrust. However, this anxiety was only articulated among scientists who worked within fields that were experienced as controversial. The majority of the interviewees imagined a trusting public. Moreover, this trust was considered crucial in establishing a legitimate space for the scientists to work as well as providing an important motivation for doing science.

## **Conclusion: the ambivalent imagination of the public of science and the importance of epi-knowing**

This paper started from the observation that previous studies have argued that scientists tend to employ a deficit model in their accounts of their public and the public's ability to engage and participate in scientific processes (Barnett et al., 2012; Besley and Nisbet, 2013; Heidenreich, 2015; Maranta et al., 2003; Walker et al., 2010). Lack of scientific literacy has been considered to produce scepticism and resistance. My aim was to critically investigate the role of the deficit model in scientists' imaginations of the public. Inspired by the insights of Heidenreich (2015), I asked first about the content of these imaginaries. Second, I was concerned about what it means to argue that such mental constructs should be considered as emerging from the process of producing scientific knowledge. Third, I wanted to explore the gains of transcending the common focus on knowledge primarily as scientific literacy.

To begin with, this paper has shown that knowledge deficits definitively are features of the imagined public of scientists working within the fields of bio- and nanotechnology. Some interviewees linked a lack of scientific knowledge to sceptical attitudes toward science, but the most important effect of such deficit thinking was that scientific illiteracy made it pointless to include the public in research – in particular basic research characterised by uncertainties and 'slight surprises of action'.

However, as expected, the issue of ILPs turned out to be more complex among the scientists interviewed. I referred earlier to the concept of a phantom public, taken from Walter Lippman and employed by Latour (2005) and Marres (2005, 2007). This concept proposes that the public of science is what Marres (2005: 216) calls ungraspable and vague, leaving scientists to be puzzled. However, the findings in this paper suggest that ambivalence is a more adequate term than perplexity when we inquire into the "physiology" of ILPs. To the interviewed scientists, their imagined public is not an ungraspable but an ambiguous entity.

Exploring the ILPs of the interviewees, the paper identified three dimensions of the ambiv-

alence of scientists: (1) knowing, (2) enabling, and (3) trusting. With respect to my research questions, first, they represent a way of describing main aspects of the content of these imaginaries – what I called the physiology of ILPs. Second, these dimensions as I have described them clearly show how mental constructs like ILPs intimately are linked to interviewees' understanding of the process of producing scientific knowledge. Third, as I will show in the rest of the conclusion, they provide tools of transcending the common focus on knowledge primarily as scientific literacy.

With respect to knowing, a deficit in the public's scientific literacy was acknowledged and also imagined to potentially cause reluctance. However, the interviewees did not expect to find – nor did they ask for – a high level of scientific literacy regarding their research topics. They were more concerned that the public should understand the social context of science and its contributions to society, that the public was engaged in what I call epi-knowing. Furthermore, most of the interviewees thought the ILPs' level of epi-knowing was satisfactory. The scientists experienced the public's knowledge relating to matters of concern and wider aspects of science, such as its value and impacts, as providing support for their research. With respect to epi-knowing, the epistemic split between the scientists and their ILPs regarding scientific literacy was dissolved. Everybody, also the scientists, were considered to be citizens.

Concerning the second dimension, enabling, the attention to epi-knowing was central in the scientists' understanding of the public's agency and, accordingly, the public's participation and engagement in science outside the core tasks of daily scientific practice. The interviewees, above all those engaged in basic research, argued that direct public participation in their work was of little relevance because of their own limited agency and the public's lack of scientific expertise. Even these scientists considered themselves unable to predict how their work would develop.

This was considered different when the focus was on epi-knowing and consequently on the context of their research. This context included issues like prioritising and funding of science, what we could call the policy dimension of the science

society relationship. In this arena, the public was considered legitimate decision-makers; citizens with agency, for example with respect to voting.

The third dimension of ambivalence was trusting. Trusting was seen as a precarious quality of ILPs because it generated support for science but also because it motivated the scientists to do their research. The interviewees thought that a trusting public presupposed proper communication of scientific objectives and a common understanding of values and impacts; that scientists and the public shared epi-knowing with respect to science. There was also a widespread belief that the ILPs actually were trusting science and scientists.

The interviewees of this study were scientists working in Norway, thus also talking about their relation to a Norwegian public. This may limit the generalization of our findings to science society relations in other countries. However, as shown by Davies and Horst (2015), the language of RRI has an international character, and the EU funding system has a strong position in the dispersion of RRI measures. This means that scientists in several European countries now face similar demands of engaging with wider set of societal actors. The ambivalence model thus may hold potentially important lessons with respect to RRI and the changes in the science society dialogues required by this policy programme. We have seen that scientists strive to uphold their autonomy and engage in boundary work in a way that seems to counter basic RRI ideas of public participation (Gieryn, 1983). However, this position should not be confused with arrogance and lack of reflection. Rather, what is articulated is a high degree of ambivalence regarding what public engagement is supposed to be. This ambivalence should be considered carefully and not be dismissed as just another articulation of the deficit model.

As noted previously, the deficit model links lack of scientific literacy to scepticism and distrust in science. The findings in this paper as well as in Heidenreich (2015) suggest that many scientists do not see this link when describing their ILPs. Furthermore, as Alan Irwin (2014) argues, we should not dismiss that there are knowledge deficits and that such deficits are performative with regard to public participation. Instead,

we should notice how the interviewed scientists point to epi-knowing as a common ground, an Agora (Nowotny et al., 2003) where science society dialogues may be performed to explore the context, values, and effects of research efforts. An interesting example of such dialogue is the Dutch initiative to involve the public in carving out the trajectory of the national research agenda. Through a national survey, the Dutch population was asked to submit questions about what they believed were important issues that their national research programmes should address. The project received 11 700 submissions which were used as a starting point to formulate research priorities (Dutch national research agenda, 2016).

With respect to the role of epi-knowing in science society dialogues, it is important to note how in such contexts scientists draw on their

identity as scientists as well as multiple other identities – as parents, as caretakers for their students and, most importantly, as common citizens (see Merton, 1976). Perhaps the demands that scientists face – for example, through RRI – expand their roles and responsibilities in such a way that their conflicting positions become more evident?

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**María Puig de la Bellacasa (2017) *Matters of Care: Speculative Ethics in More Than Human Worlds*. Minneapolis and London: University of Minnesota Press. 265 pages. ISBN: 978-1-5179-0064-9**

Sonja Jerak-Zuiderent

s.jerak-zuiderent@amc.uva.nl

The book *Matters of Care: Speculative Ethics in More Than Human Worlds* is about involvement; not about getting involved, but about how we are already always involved in one way or the other, together with “objects, other animals, living beings, organisms, physical forces, spiritual entities, and [other] humans” (p. 1)– whether we want it or not. This means the book does not propose that care is a *resource* that can be added to the world through scholarship; it is already there and we are implied in it. And, if we follow the suggestion of María Puig de la Bellacasa, “speculative exploration of the significance of care” (p. 1) involves attending to care as it is already going on in, often neglected, practices. This means that “the ‘ethics’ in an ethics of care cannot be about a realm of normative moral obligations but rather about thick, impure, involvement in a world where the question of how to care needs to be posed” (p. 6). With care being inherently situated and normatively ambivalent, it would need to be quite present in our research.

And yet... “Nobody has ever asked me this... It is a question that you do not get very often.” That is the response I got when recently, in interviewing a philosopher, I asked her what she cares about in her research. I was paraphrasing the central question in *Matters of Care* about how to do our research ‘as well as possible’. The reply shows that this book serves a real need.

If scholars are no longer posing the question what they care about, let alone about how they are “putting in the work to ‘care for’” (p. 5), this may be because we get increasingly used to the question of ‘the good’ in academia as suspect. Questions of goods now come with a set of standard answers, and new externalized criteria that we must start adhering to. Yet those standard answers and external criteria reduce our capacities to imagine good science. I keep coming across (at least) four standard responses which suggest measures to warrant the concern for the academic good:

1. through procedures and the mushrooming developments on research ethics and integrity, including proposals to introduce something like an ‘integrity passport’ for academics’;
2. through a combination of performance and assessment measures like the h-index and an increased quest for excellence;
3. through enhanced transparency of the research process, for example through ‘open data’ requirements about making findings available in repositories, and
4. through focusing on the (envisioned) impact of scholarship on society.

With all such answers, most people feel a little uncomfortable. They itch. But many of us scratch and move on. Many feel we have to ‘play the game’. And each of these standard responses provides some form of comfort by externalizing the

question; reducing complex STS analytic textures to sometimes seemingly productive strategies. Others keep on scratching by repeating how all such standard answers stay within an oft-trodden neoliberal-welfare-governance-state trope-trail. But whether scratching briefly or continuously; scratching often makes the itching worse and keeps the exploration of alternatives at bay.

*Matters of Care* proposes a radically different response to the question of how to respond to issues of ethos in research. Puig de la Bellacasa offers analytical sensitivities for how to do research 'as well as possible'. The book then is essential reading for all those who feel there *must* be better answers, better reasons for why they ended up as scholars - or getting trained as such; particularly scholars who find kin amongst others focused on STS questions and concerns. But, although this is an important reason to read the book, this is not what it is about.

Puig de la Bellacasa, rather than prescribing what the good in academia (or anywhere else) could be about, offers with *Matters of Care* a richness of sensitivities to realize – taking the double meaning of the word literally – our always already ongoing involvement in more than human worlds and the possibilities and obligations this realization of involvement entails. This 'matter-ialised' involvement, she argues, lies in realizing neglected possibilities *and* obligations to disrupt implicit or explicit splits between thinking and living in more than human worlds. The book elaborates in two parts how to realize our involvement. First, it argues for a thorough re-imagination of 'knowledge politics'; not by offering yet another turn – a turn to care, but rather by refreshing the moral and political value of care by scrutinizing the historically trodden paths of feminist and STS-companionships for vital complications of neglected matters. The second part is situating the conceptual consequences of a knowledge politics *with* care into the relational webs in *naturecultures*. Puig de la Bellacasa shows that our imagination of technoscience and naturecultures materialize in our (in)capacities of living in difference together in more than human worlds. This imagination refers also to concepts that are organized collectively as a '(common) good' – for example, academia, democracy, economies, nation states, communities.

Taking this argument seriously – that to realize our possibilities and obligations of living in difference together in more than human worlds materialises in the often neglected, situated potential of affective, ethical, and hands-on agencies of practical and material consequences in the ecologies of our research – how and whom does it help to think of the academic good as being part of a game or of a collective excellence sport-discipline? And at what costs do we play such a game and compete to excel? And is there a way to *not* ignore the involvement and obligation to "the specificity of moments, particular relations, of ecologies where the ethical is both personal agency *and* embedded in the 'ethos' of a community" (p. 151) without "defining in advance a code of conduct or a normative definition of right and wrong" (p. 152)? As in the h-index, the integrity passport, the open data repository, or the measured impact of modern scientific practices.

Although grand narratives are ubiquitous and particularly promising in policy terms, *Matters of Care* encourages us to confidently resist the rhetoric of playing the game of 'solving problems' by responding to any question – be it academic malpractice, poverty, racism, ecological crisis like climate change, wars – in standard ways or by pretending that *our particular* research is not directly related to the textures of more than human worlds it is situated in. Thinking our research lives with care, we realize our involvement by learning to firmly slow down, to complicate attempts of grand epics by paying attention to situatedness and its neglected possibilities, neglected temporalities in the "living mesh" (p. 20) of the everyday in research life.

Slowing down during the recent interviews I made concerning good science/research<sup>2</sup> proved quite generative: Once people pause at the question, some start highlighting things and situations they care about, that involve the work of 'caring for', and that according to them are part of good research but that are somewhere lost outside the research-project-cycle that increasingly dominates our imagination. The interlocutors, for example, referred to moments such as not immediately rushing off after having given a lecture for PhD students and postdocs, and leaving their office door open to invite their questions related to their unfolding research

lives. These moments are not about transferring knowledge to 'recipients', but speak about knowing that happens somewhere in between the mesh of the everyday. These examples might not be surprising to anyone, because they *do* take place and many of us do things like that or similar things like regular walking seminars or writing retreats. However, what *is* surprising, is that these everyday moments of good research are completely absent from the general debates and concerns about good science. What makes it so hard to articulate these everyday moments in such debates, but that at the same time very much contribute to the 'as well as possible' of science?

Articulating such fleeting practices as *Matters of Care* identifies is a way to argue for and at the same time to nurture, a politics of not only showing versions of 'as well as possible' worlds that are already ongoing, but also how these get neglected. Situating this argument in a texture of companion stories of feminist technoscience work, Puig de la Bellacasa shows how this requires the capacity to appreciate the tension of thinking *and* living an ethos entailed in situatedness.

In terms of the situatedness of this review, I pause for a moment at open data; one of the emerging ways to warrant good science within and across disciplines. Although medical sciences and pharmaceutical industry have unfortunately proven to us that it is a good idea to make transparent what kind of knowledge politics gets promoted by 'following the money', extrapolating this approach to all scholarly fields may well be disastrous. It would surely not help to "unhinge some of the moral rigidities" (p. 11) of externalized research ethics. Open data explicitly neglects the complications that the notion of 'data' brings with it, and can therefore fuel accelerations in a problem-solving data-science-world. By letting go of situatedness as a firm stance, such data-science-worlds-thinking risks damage to and ultimately destruction of, the circulation of care as "a thick mesh of relational obligation" (p. 20) cultivated by for example not running away after the lecture, keeping the office door open, walking seminars or writing retreats.

Care thus becomes paying attention to such neglected moments, but also about learning to ask different questions about data, for example

about why we think machine learning will lead to better care robots, but not questioning the argument that having humans carry out that care would be too expensive, as Lucy Suchman (2018) recently did. Or about why the moment data exploration is done by pregnant women who are given access to their records, their assiduity and concerns about the many missing data points in their records get classified by professionals as bothersome, which raises, as Brit Ross Winthereik (2018) recently did, the question about the spaces for patients in data work and the stark contrast with promises of open data.

*Matters of Care* are thus not developed through establishing dividing lines between concepts, thinkers or disciplines, but rather through speculatively intervening through relating multifarious commitments to situatedness. Puig de la Bellacasa develops and lives her argument in *Matters of Care* symmetrically in how she re-presents it. She moves from thinking/living with care in technoscience to thinking/living with care in naturecultures – while emphasizing that this order is not prioritizing thinking/concepts before substance.

It is in the rich second part of engaging with everyday ecologies of sustaining and perpetuating life while moving through it, that I would have loved to learn more of; the "living mesh" (p. 20) of the knower who thinks and lives *through* the bumpy circulations between thinking/living *with* care and thinking/living *through* care. Although it is not developed as such and in some way even defies development, I see in the emphasis on the continuous search for "ways of thinking that engage care" (p. 18) also a relational obligation towards the knower as a living mesh. Engaging "more substantially and deeply in telling stories around experientially observed and researched terrains" (p. 21) can then not 'merely' make "(...) the complexities of thinking with care even more intricate" (p. 21); it offers also the possibility to explore the neglected epistemic potential of the "affective, ethical, and hands-on agencies of practical and material consequence" (p. 4) of our thinking. Not by splitting it from the substances of our everyday research lives, but rather by developing a similar sensitivity for the invisible work that constitutes our knowing *through* "affective,

ethical, and hands-on agencies of practical and material consequence" (p. 4) of thinking and living.

Appreciating the initial itching as instantiation of 'ontological disconcertment' (Verran, 2001) about academic goods (and bads) may help point to even thicker possibilities to tell "involved stories, neither theoretical nor descriptive, open to alternative readings, yet situated" (p. 22). Appreciating itching offers a possibility to avoid "[t]he fatal flaw in (...) standard STS analytics" of conceptualizing the STS scholar "as removed observer" (Verran, 2017: 20) and rather think and live a two-wayness of concepts not only between

the knower and her mind (Verran, 2016) but also between the knower and the specificities of the ecologies that the knowing emerges from. This allows us, for example, to attend to the neglected possibilities and obligations to think and live academia in neoliberal democratic nation states and economies with care – troubling "the democratic assembly of articulate concerns as well as generat[ing] possibility" (p. 18). *Matters of Care* offers tentative guidance that is novel in its ability to attend to what is already there. The book is a crucial resource for all those who prefer ground-caring over ground-breaking scholarship.

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## Notes

- 1 Suggested as a possibility in a presentation during the conference in Bonn, Germany, *Why Research Integrity Matters to You*, February 5-7, 2018.
- 2 These interviews are part of a project on *Achieving Good Science – A Cross-disciplinary Study* that I am involved in – Project leader Jeannette Pols and Amade M'charek, and Jonna Brenninkmeijer and myself as project investigators; financed by the Netherlands Organisation for Health Research and Development (*ZonMW*).

**Benoît Godin and Dominique Vinck (eds) (2017) *Critical Studies of Innovation: Alternative Approaches to the Pro-Innovation Bias*. Cheltenham, UK: Edward Elgar Publishing. 335 pages. ISBN: 978 1 78536 696 3**

Barbara Bok

*bbok@swin.edu.au*

Traditional studies of innovation focus on the creative, and the priority aspects of innovation (being first with something new) and emphasise that innovation is 'good'. The book under review here presents studies of literatures and phenomena that are left out of the dominant innovation discourse. *Critical Studies of Innovation* makes an important contribution in the way it illuminates what is missing from how we imagine and talk about innovation. Specifically, at the centre of the book is a willingness to bring to light the 'dark side' of innovation, so that a generative critique in which we learn how to 'metabolise' this dark side becomes possible. In reviewing the book's approach, I nonetheless find that the book neglects an important topic.

By metabolising, I mean something like the following. According to the mainstream model, success is clearly separated from failure, and creativity clearly separated from maintenance. According to the analysis proposed in this book however, success becomes inclusive of failure and failure part of success. And so too for creativity and maintenance. The effect is of an expansion of actor networks, a re-accounting of the work (energy) involved, and a re-assessment of the benefits (or lack thereof). The 'dark side' of innovation refers to what is left out of the pro-innovation bias. For example, a withdrawal of a product is considered as solely consequence of some inadequacy. Thus withdrawals (failures) are neglected

by mainstream scholars. Yet, the translation model presented here, helps identify that a withdrawal of something is in an odd way, the very purpose of an innovation. Thus, metabolising the dark side of withdrawals is to identify a different sociotechnical network of actors with different purposes.

Humans are always grappling with complex global challenges. If the way that innovation is studied and understood is limiting energy for change, restricting rewards for change, or ignoring particular consequential aspects of innovation, then that concerns and interests me. Read widely the book could help cultivate a wave of thinking differently about innovation. Required reading for students of science and non-science courses in later years perhaps? The book will appeal to teachers and researchers looking for ideas to expand their topics of discussion, and to practitioners and professionals who are looking for possibilities to fashion interventions for change.

The chapters are arranged according to a four-part argument between an introduction and conclusion. The four-part argument works well as each chapter basically repeats the book's main claim that something is missing from innovation. However, it is not the argument itself that helps in surfacing the feeling at the centre of the book. More likely it is the cumulative effect of different situations re-viewed and re-assessed through different frames with different criteria for attributing success. I enjoyed reading all the chapters.

The four chapters of Part I identify problematic aspects of mainstream innovation frameworks and narratives. Right from the start the meaning of innovation is unsettled. The four studies identify: that, seen historically, the meaning of innovation has changed dramatically over centuries and a particularly narrow meaning is current; important elements like organisation is excluded and so too the implications; the unintended consequences of adopting innovation best practice is imitation, but imitation is neglected by mainstream innovation study, and; excluding the socio-political roles of the state other than the funder-facilitator role leaves the socio-political implications of innovations unexamined. For example, innovation did not always carry the meaning of 'good'. The Reformation is a key moment of change in the meaning of innovation. Innovation began to be used to refer to something 'bad'. Enemies were accused of innovation. Innovation was contrasted to tradition and custom. It indicated contempt, danger and revolution. Insights are that innovation as being 'good' should not be taken for granted, innovation is both a result and a cause of the culture and dominant ideologies of the time, and excluded elements obscure the visibility of important good and bad effects of innovation, including missing cycles of narrowing effects on innovation.

The three chapters of Part II examine examples of neglected aspects of the pro-innovation bias. The studies examine: how actors often deliberately choose strategies to eliminate or reduce something because it is the right thing to do, yet, except in few concepts like responsible innovation, phenomena like withdrawal, de-adoption and destruction are not considered; the dynamic interplay between 'unlawful' innovation and the legal system through a legal grey zone, and; attended and unattended consequences of financial innovation and the obligations to recipients of change (including non-adopters and non-stakeholders) in a more balanced way through a combination of stakeholder and ethical perspectives. Models from STS help to make visible dynamic arrangements and mutual redefinitions of actors and the breaking and rearrangement of their ties and relations. The case studies of chapter 5 demonstrates that 'less' or 'no' is not simply a case of 'simplicity' or 'frugality' and that choices

about withdrawal can come from recognising the risks posed by, for example, pesticides. Other times, choices are driven by critique that undermines or disqualifies certain actors, practices or entities, such as, for example, the chemical or mining industries. The insights show that including neglected aspects through alternative and more inclusive models helps with studying the transformations of society.

In Part III, three chapters offer studies of resistance to innovation. They focus on motivators and enablers of resistance; sociotechnical resistance as a problem-solving (re-innovation) activity involving a range of actors by studying the relation between technology and ideology, and the conditions that lead companies to choose strategies to slow their pace of innovation or to not-innovate. By viewing resistance through a model of pain in self-monitored movement that respond to viral contamination and pestilence, resistance (negative perceptions and pain) becomes integral to the functioning of innovation (chapter 8). More importantly, where innovation and resistance are clearly separated in the mainstream model, with the pain framework, innovation has become (indeed, cannot occur without) resistance, and resistance has become (part of) innovation.

Part IV has five chapters that focus on alternative frameworks and models for studying innovation. The studies describe: viewing innovation as a process of learning including learning from failure rather than seeing failed innovation as a loss or seeing innovation as a process toward success without any failure dynamics or failed outcomes; examining novelty and change dynamics from the industry level shows that the industry is maintained and repaired in a way that keep it functioning in largely the same way; how discourse on innovation includes elements that promote faith and self-serving practices in innovation which reinforces the benefits of innovation and ultimately promotes more faith in innovation; a NOvation model of innovation, and; a biological model of innovation. I particularly enjoyed reading the analysis of innovation in the automotive industry that shows automotive innovation as small and incremental activity against a background of sameness, stability and conservation obtained by standardisation (chapter 13). The

insight is to use frameworks that assist examination of the currents of innovation and also the counter-currents that prevent systemic innovation.

Finally an observation on a topic nearly entirely missing from the book. The contributors demonstrate skill in identifying what is missing from other's work. Yet, neither mainstream innovators nor critical researchers of innovation are free from giving prominence to certain things and excluding and neglecting other phenomena (creating another dark side). Critical scholars of innovation too are subject to the forces of maintenance, failure, non-adoption and withdrawal. I would have liked to see more discussion about the cultivation necessary for a willingness to metabolise the dark side. My point is that illumination/obscuring are iterative. Really significant

innovations would be suggestions on how to keep in view the inevitable 'dark side' of any innovative approach, and how to maintain an appetite for the inevitable othered.

Recognizing and working with undesired qualities requires energy and resources to keep separations in place, repressed and denied. The contributors to this book demonstrate that frameworks and models different from the traditional model of innovation can help to 'metabolise' the dark-side of innovation. Innovation here becomes inclusive of and cannot function without those elements that the traditional model excludes, while the excluded elements become innovation. The effect of innovating with innovating is to find renewed energy for change and to distribute more widely the rewards of innovation.

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