climate change

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EU Climate Change Case Studies

ClimateXChange

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This research, commissioned on behalf of the Scottish Government, reviews relevant national Climate Change and Energy strategies, plans and policies from elsewhere in Europe.

With a focus on heat, transport and agricultural policies, a range of countries were selected resulting in a suite of seven case studies: heat in Germany, the Netherlands and Sweden; transport in the Netherlands and Norway; and, agriculture in Denmark and France.

Findings

This section provides a summary of the common themes emerging from the case studies, and is followed by an overview of each of the case studies. The case studies are then provided in full in the Annex.

Ambition

The research has shown that our case study countries are adopting a range of approaches to climate change policy which includes setting legally binding emissions reduction targets, implementing non-statutory targets, or simply following / committing to targets set by the EU for all member states.

Countries showing high ambition on tackling climate change include Sweden, which is in the process of legislating for a goal of phasing out all greenhouse gas (GHG) emissions by 2045. Norway has committed to a non-statutory aim of becoming carbon neutral, via an accelerated programme of emissions cuts and carbon trading to offset emissions, by 2050. Whilst political parties campaigning in the recent Dutch general election say they would support a new Climate Act setting out legally binding targets to 2050.

These countries, some of which have cited the UK as inspiring their climate ambitions, appear however to be encountering similar challenges, and despite setting ambitious emissions reduction targets, are struggling to deliver the necessary reductions in emissions.

Cross-party support for climate policy

Cross-party political consensus has emerged from the case studies as being important to the setting of high ambition on tackling climate change, and ensuring that future governments report on how they'll meet their goals and have credible climate policy.

Sweden's climate goal was initially proposed by the socialist and green parties and backed by a coalition of seven out of eight parties across the political spectrum. The leader of the working group on potential climate law cited the UK's Climate Change Act as one of the major influences for the Swedish cross-party agreement, which encouraged conservative parties in Sweden to lend their support to the new legislation. Despite political differences, members of the current coalition were willing to compromise and reach a united target for this highly publicly supported issue – the Swedish public traditionally being keenly aware of and concerned with environmental issues and protecting Sweden's clean air and water.

In Norway, emissions targets were met with cross-party political consensus as early as 2008. Parliament approved the government's draft Climate Policy Settlement with only minor points of disagreement.

Danish politics and governance are characterised by a common striving for broad consensus on important issues, due to a long tradition of minority governments. Since 1985, different coalition governments have been building consensus across the political spectrum, and with stakeholders, to successfully implement nitrogen management policies in the agriculture sector. Cross-party agreement and dialogue between the government and industry underpinned policy development for three decades (though the progress has been reversed recently due to a combination of agricultural economics and political factors).

During the 2017 Dutch general election, five centre-left political parties stated they would support a new Climate Act setting out legally-binding targets and deadlines until 2050, arguing that such a measure would help to 'depoliticise' climate change in the country, by introducing long term statutory obligations. Pro-environment parties that prioritise tackling climate change greatly

increased their number of seats in this election. However, the result of the election means four parties are needed to build a coalition and these may have differing views on climate change.

The importance of consistent, long term policies

The case studies have shown that consistency and stability are important to securing buy-in from key relevant stakeholders and ensuring that policies are successful over the long-term.

Discussions during the 2017 Dutch election campaign have revealed support from industrial stakeholders, including energy companies such as Shell, for a new Climate Change Act. Industry representatives have said they would benefit from clear and consistent long-term policies.

The key strength of Swedish CO_2 and fossil fuel taxation (which has been a key driver of the decarbonisation of heating) has been its stability, despite changing governments. And where necessary, the government has ensured announcements around any regulatory changes have been made well in advance, allowing businesses to adapt accordingly.

Negotiations which led to the setting of the Netherlands Energy Agreement for Sustainable Growth, commenced after the end of six cabinets (but not entire governments) in ten years. (Post the 2017 general election, there will be a new administration). This political instability, alongside inaction, put the country at risk of breaching EU targets on decarbonisation and renewable energy.

The German federal government aims to make Germany's entire building stock 'climate neutral' by 2050. A wide range of policies and programmes, dating back to 1976, contribute to meeting this goal.

Consultation on setting policy

The research showed (and some examples are below) that case study countries have consulted, as expected, when implementing climate policy.

In France, climate policies have been subject to broad based consultation including experts, public bodies, NGOs and non-state stakeholders. The result has been high levels of buy-in across the spectrum – though not always quickly. For example, the Energy Transition law – intended to transform the French economy with respect to energy use, and boost 'green growth' – required four years of negotiation, before being enacted.

Heat policy in the Netherlands has been through collaborative processes with stakeholders and public consultation. The government has set up a 'Heat Table' consisting of three working groups made of Ministers from different departments, local and regional authorities, and the private sector. The Dutch government has also undertaken an 'Energy Dialogue' over a three-month period in 2016 to engage the public on their views of how to advance the energy transition between 2023 and 2050.

Public support

Public support has emerged from the research as being important to the acceptance of climate change and energy policies.

There is strong public support in Sweden for environmental policy, largely due to a long tradition of open, free access to environmental information.

In Norway, environmental policies have been presented to the public as not inherently conflicting with economic growth, which ensured that they were met with broad approval. To encourage public acceptance of battery electric vehicles (BEVs), the government-funded agency Enova sponsored

communication campaigns, statistics on electric vehicles registrations and information on charging points.

In the public announcement on Germany's Energy Efficiency Strategy for Buildings, the government appealed to citizens to 'play their part' in achieving the 'common' target of a carbon neutral building stock by 2050. In addition to drawing on notions of 'shared responsibility', the targets have been framed in the context of broader economic and environmental benefits.

Surveys in Germany show a high degree of concern about climate change and high levels of support for the Energiewende (German for energy transition, is the transition by Germany to a low carbon, environmentally sound, reliable and affordable energy supply). A relatively high proportion of the German population regard climate change as among the most serious problems facing the world.

The recently published European Perceptions on Climate Change research outlines national profiles for participating nations (France, Germany, Norway and the UK) and results of a survey of public perceptions of climate change and the energy transition, and may also be of interest.

Policy Challenges

Despite setting ambitious climate change targets and employing good practice, through broad consultation, ensuring public support etc., the research has shown that case studies are still experiencing challenges in the different policy areas examined.

Setting sector targets for agriculture is difficult as emissions largely arise due to biological processes rather than technological ones. As such, there are fewer 'levers' that might be employed in agriculture as compared to the energy-related CO_2 emissions of other sectors of the economy. The implication of not / delaying setting targets for the agriculture sector is that other sectors will need to achieve greater GHG emissions reductions to compensate for agriculture's lesser short- and medium-term contribution.

Despite accounting for nearly 20% of French GHG emissions, within the National Low-Carbon Strategy (SCNB) framework, agriculture has the lowest GHG reduction target of any sector; 12% by 2028 and 50% by 2050. This recognises the relative difficulty in reducing CH_4 and N_2O emissions.

Agricultural climate change policies are expected to evolve soon in Denmark, to align the sector with the overall Danish Climate Policy Plan which aims to achieve a 40% reduction in GHG emissions by 2020 in comparison to 1990 levels. Though agriculture is considered in the Climate Policy Plan, there is no GHG mitigation target currently assigned to this sector.

While support for the goals of the Energiewende in Germany is high, and in spite of a wide array of initiatives, the annual rate of energy efficiency retrofit remains stubbornly difficult to raise from 1% to 2%.

Norway has one of the most generous and long-running incentive structures for BEVs in the world. This has enabled dramatic growth in electromobility, particularly over the past few years as technological and supply-side barriers have been removed. Despite the recent surge in growth, less than 3% of the total car fleet is electric; the remainder is a roughly even split between petrol and diesel vehicles.

Summary

As the number of case studies produced was limited, the above is not a comprehensive view on European countries' climate change policies, but gives a sense of how other countries are dealing with the challenges of meeting ambitious climate goals. Further work would be required to undertake additional analysis of policies from other countries and different sectors.

Case Study Summaries

Germany: Heat

- Germany used system-wide modelling to develop sector-specific targets, including an 80% reduction in non-renewable primary energy demand by 2050.
- Extracting a target from an economy-wide model allows integration with other aspects of the energy system (e.g. the infrequent use of fossil-fired power stations to fill gaps in renewable electricity could also provide heat). However more refined analysis was required to map the possibilities for achieving the 80% buildings target and this found that nearly the full potential for both energy efficiency and renewable heat would be required.
- Converting the building stock to be "climate neutral" demands a wide variety of interventions. As well as fitting the right technologies to the right buildings, policies need to be tailored to be attractive to different constituencies.
- While support for the goals of the Energiewende is high, and in spite of a wide array of initiatives, the annual rate of energy efficiency retrofit remains stubbornly difficult to raise from 1% to 2%.
- The balance of powers/competencies across local government, the Länder and the Federal government means a large number of measures have been put in place, allowing for some policy innovation and targeting, but perhaps also leading to an excessively complex funding landscape. Relationships across multiple levels of governance have also stymied a policy whose advocates saw it as an important means of reaching households currently not attracted by low cost loans.

Netherlands: Heat

- In 2016 the Dutch Government set out its long-term vision for a (nearly) decarbonised domestic heat sector by 2050.
- 2020 – 2023 heating sector decarbonisation targets primarily focus on energy saving in buildings.
- Policies for 2023 – 2050 are yet to be developed.
- Decreasing natural gas resources and problems with gas extraction lead to a widespread support for decarbonisation across the political spectrum, civil society and industry.
- Stakeholders from different sectors (from industry to NGOs) as well as various political parties are currently pushing for more concrete decarbonisation targets. This may, however, create tensions around the underlying policy trade-offs visible, which have thus far been largely obscured by the lack of concrete proposals.
- Going forward, the Dutch Government has thus far adopted a collaborative approach. It is currently involving industry stakeholders and other levels of government in the development of a broad strategy for a heat transition.
- The Dutch Government sees its role as a coordinating one, with local and regional authorities taking the lead in collaboration with other stakeholders.

Sweden: Heat

- Sweden has a target to phase out fossil fuels in heating by 2020.
- Sweden has no natural fossil fuel resources and limited connectivity to a natural gas grid, which has favoured biomass as the key fuel for district heating.
- Taxes on CO_2 and fossil fuels, combined with long term policy stability were the critical factors in enabling low carbon technology uptake and ensuring business stakeholders' trust.

Business and other stakeholders are involved in decision making via consultations on government proposals before these are presented to parliament.

- The CO_2 tax was combined with tax relief in different sectors, redistributing the taxation but not increasing the total amount.
- Biomass and waste-fired CHPs are supported with tax exemptions and subsidies.
- New district heating markets were established with sustained government support. When the market reached maturity, further technology development was encouraged through private sector competition underpinned by targeted tax and subsidy regimes.
- Further CO_2 emissions reductions in district heating are expected from increase in waste heat utilisation from industrial and chemical processes and energy demand decrease.
- In addition to relative cost, investment in domestic research & development was a key factor for high heat pump uptake.
- High building efficiency standards ensure low-income households are not penalised by fuel taxation.

Netherlands: Transport

- The Netherlands transportation decarbonisation policies under The Energy Agreement for Sustainable Growth seeks to reduce transportation emissions by 60% by 2050 (compared to 1990) with and intermediate goal of 25 Mt CO_2 reduction (-17%) in 2030. Decarbonisation targets were made because of government inaction, and industry desire for long-term policy.
- Full electrification of the train system was made possible by early completion of wind farms in Northern Europe.
- Transportation decarbonsation policies take advantage of early Electric Vehicle (EV) market penetration. The Green Deal helps facilitate EV infrastructure investment through public-private partnerships The Dutch government will look to close this mechanism in 2020, when they expect charging infrastructure will be sufficient and/or economical to support continued EV development.
  Transportation decarbonisation targets contain small policy changes in the short-term, and require further research for long-term goals. Pre-market technologies are being researched at Dutch labs and universities. These future technologies will support current EV infrastructure which has seen rapid success thanks to regular industry-led consultations.

Norway: Transport

- There is a high degree of support and acceptance of electromobility from the political establishment and the general public and industry in Norway.
- Norway's emissions reduction targets were met with cross-party political consensus as early as 2008.
- Norway has one of the most generous and long-running incentive structures for battery electric vehicles (BEVs) in the world. This has enabled dramatic growth in electromobility, particularly over the past few years as technological and supply-side barriers have been removed. Despite the recent surge in growth, less than 3% of the total car fleet is electric; the remainder is a roughly even split between petrol and diesel vehicles.
- EV incentives have evolved in a piecemeal fashion over a long period of time. The removal of VAT rates, registration fees and annual motor taxes has progressively encouraged uptake. Other incentives to purchase BEVs have been implemented, such as access to bus lanes, free parking and tolls, and reduced ferry charges. Norway's high taxes on conventional vehicle ownership has made low emissions alternatives more attractive.
- Concerns have been raised that the success of EV policies have raised the cost of state support and the burden on public transport infrastructure. Despite earlier policies that

extended the zero rate of VAT for EVs from 2017 to 2020, the government's latest policies propose a gradual phasing out of other incentives, such as low registration taxes and ferry rates or unconditional access to bus lanes.

Denmark: Agriculture

- Water and air pollution concerns have been driving agricultural nintrogen (and phosphorous) policies in Denmark for 30 years, resulting in considerable improvements in nitrogen utilisation and synergistic effects on N_2O emissions
- Cross-party agreement and dialogue between the governments and the industry underpinned policy development for three decades, though the progress has been recently reversed due to a combination of agro-economic and political factors when external market and financial impacts gave profitability and viability increased importance, with environmental regulations (particularly the nitrogen quota) seen as a restriction
- Comprehensive statistics from multiple sources on livestock numbers and nitrogen use, along with wide ranging measurements of nitrogen compounds in the aquatic environment and air, provide quantitative basis for monitoring and policy development
- All nitrogen sources on farm have been targeted, including synthetic nitrogen, manure nitrogen and nitrogen in livestock feed; particularly the reducing nitrogen quotas creating a strong incentive for technological improvement in manure nitrogen utilisation
- Technological development in livestock housing and manure management achieved in Denmark ahead of most other European countries allowed the supporting industries to become provider of these solutions internationally
- Regulatory approaches worked well while efficiency savings and technology improvements could support farmers complying at a low cost (or actually generating savings)

France: Agriculture

- Between 1990 and 2014, GHG emissions from agriculture in France decreased 5% from soils (mostly as a result of better mineral nitrogen fertiliser management) and 8% from livestock (primarily methane produced from digestion by beef and dairy cattle).
- France's policy framework is complex, with a multiplicity of goals, objectives, and targets.
- Stakeholder consultations have been influential to generate broad-based buy-in to the need for action related to GHG emissions, climate change and transitioning away from fossil-fuel based sources of energy.
- Despite a multitude of policies, objectives and targets, GHG emissions from agriculture in France are little changed since 2005, with the vast majority of reductions achieved prior to 2009, the implementation of the first Grenelle law.
- It is unlikely that French agriculture will meet its high level target of a 12% reduction in GHG emissions by 2020 relative to 1990.
- Achieving longer-term targets within agriculture will require tackling methane and nitrous oxide emissions. CO_2 emissions are a small proportion for this sector, thus providing less potential to make a meaningful impact.
- Targets likely to be achieved are those related to market share of organic produce sold by institutions. The intent is to provide a demand-pull incentive for increased acreage converted to organic methods.

Annex: Case Studies

Case study 1: Climate Neutral building stock in Germany

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Policy description

The German federal government aims to make Germany's entire building stock "climate neutral" by 2050 (German Government Climate Action Programme 2020). The government is pursuing a cross-cutting strategic approach which includes high thermal performance standards of new buildings, progressive improvements in the energy efficiency of the existing building stock, deployment of building-level renewable heat technologies and use of both CHP and renewable sources in district heating.

A wide range of policies and programmes contribute to the climate neutrality goal (a selection of which is shown in Table 1). These include grants and subsidised loans for energy efficiency (both retrofit and new buildings going beyond regulated minimum standards) through the KfW bank, building standards regulating both thermal performance and heat supply for new buildings (by stipulating minimum levels of either renewable heat, CHP or district heating), and grant funding, e.g. through the Market Incentive Programme, for renewable heat installations. In addition to Federal government financial support, the Länder and even municipalities organise complementary regulation and funding programmes.

Table 1: Key legislation and policies supporting a climate-neutral building stock

Name	Inception	Latest Revision	Type	Key building-related provisions
National Energy Efficiency Action Plan (NAPE)	2014	n/a	Strategy	Expansion of funding for refurbishments (e.g. the KfW-run C02 Building Modernisation Programme) and the introduction of tax incentives for efficiency measures on the national and federal state level. Transposes EU Energy Efficiency Directive (2012/27/EU)
Market Incentive Programme (MAP)	1999	2015	Grant Funding	Along with the KfW bank, MAP is the main financial tool for promoting renewable heat, mainly in existing buildings (e.g. solar water heating systems, heat pumps, pellets/woodchips)
Act on Energy Saving (EnEG)	1976	2014	Law	Buildings must comply with several minimum energy and heating performance standards. Addresses technical aspects related to replacement of boilers, thermal insulation, energy performance certificates, etc. Transposes Energy Performance of Buildings Directive (2010/31/EU)

Energy Saving Ordinance (EnEV)	2002	2015	Law	Sets energy performance requirements for new buildings/existing buildings in case of major renovation. New builds must not exceed the annual primary energy requirement of a corresponding reference building and must comply with prescribed minimum component standards. Transposes 2010/31/EU. Latest tightening of standards came into force in 2016 with max energy requirement 25% lower than 2014.
Renewable Energy Heating Act (EEWärmeG)	2009	2015	Law	targets a 14% share of renewable energies for heating and cooling in the building sector by 2020. Introduces an obligation for using a certain share of renewable energy in new buildings if this is economically possible.

Targets

The Government has set a (non-statutory) target to reduce primary non-renewable energy demand in the building sector by 80% in 2050 relative to average 2005-08 levels ('Primary energy' forms are here classed as fossil fuels, liquid/gaseous biomass, solid biomass, electricity, and district heating. Solar thermal and other ambient sources (geothermal, water, etc. are considered 'final energy'). The target is absolute (i.e. it isn't set by reference to the size of the building stock) but is described as an "order of magnitude" target. It can be achieved by a combination of reducing final energy demand and replacing fossil sources with renewables.

The target was first articulated in the 2010 Energiekonzept which drew on a study commissioned by the Federal Ministry for Economic Affairs and Energy (BMWi). This study explored a range of modelled scenarios to demonstrate that economy-wide climate change objectives were achievable (i.e. GHG reductions of at least 40% by 2020 and 80-95% by 2050, relative to 1990 levels), and that economy-wide primary energy consumption could be reduced by half by 2050. The target to reduce non-renewable primary energy demand by 80% was thus one of a range of scenario-informed targets which (a) were regarded as feasible and (b) would together meet the economy-wide target. The scenarios included ongoing use of fossil gas in power generation as a means of managing intermittent renewable production. This was regarded as more efficient if operated as CHP and makes up the bulk of the remaining 20% fossil fuel input to heating[1].

Table 2: Targets set by the Energiekonzept (2010)

	Climate Targets	Renewables Targets		Efficiency Targets			
year	GHG (versus 1990)	Share electricity	Share total	Primary Energy (versus 2008)	Buildings (versus 2005-2008 average)	Energy productivity	Building renovation (annual rate)
2020	-40%	35%	18%	-20%	-20% (final energy)	Increase by 2.1% p.a.	Doubling from 1 to 2%
2030	-55%	50%	30%				

[1] Edinburgh University, 2015 interview with an analyst who managed production of one of the scenarios used by the Federal Government in drawing up the Energiekonzept.

2040	-70%	65%	45%				
2050	-80%	80%	60%	-50%	-80% (non-renewable primary energy)		

Public debate and scrutiny of the 2010 Energiekonzept targets predominantly focused on electricity generation, and this intensified in 2011 in the wake of the Fukushima disaster and the decision to phase out nuclear power in Germany. Implications for buildings were thus relatively absent from debate, and only recently have more detailed constraints on achieving the 80% target been analysed. The Energy Efficiency Strategy for Buildings, published in November 2015 commissioned detailed scenarios for meeting the 2050 target. On the efficiency side, the greatest savings potential lies in heating applications, followed by hot water, lighting and cooling/ventilation. The main renewable energy sources are renewably-sourced electricity for heat pumps and district heating as well as biomass, solar thermal and ambient heat.

An assessment of the limits to each of these options formed the basis of a scenario analysis: for efficiency, a maximum final energy savings potential by 2050 of 54% compared to 2008 levels, while for renewable penetration, an upper limit of 1,800 PJ (around 50% of 2008 consumption). This suggests quite a narrow space of possibility, narrower than many previous estimates had assumed; efficiency gains of 36-54% would need to be matched by a renewable contribution of 69-57%, respectively, in order to reach the overall 80% decarbonisation target. Moreover, this target range was compared against the 'business-as-usual' prognosis, which revealed only a 60% reduction by 2050.

Efficiency targets and associated policy initiatives were bolstered in 2014 with the release of the 2020 Climate Action Programme and the Energy Efficiency Action Plan (NAPE). These policies were enacted amid concerns that Germany was not on track to fulfil its overall target of a 40% reduction in GHG emissions by 2020. This partly reflected the persistence of coal use in the power sector, but also the difficulties of increasing the rate of efficiency renovation in the building stock from around 1% per year to a target of 2% (DENA 2015). Indeed, the target of a 20% reduction in final energy demand for heat by 2020 is projected to be missed (BMWi 2015).

Timescales

2020 and 2050 are crucial dates across German energy policy, with final and primary energy demand targets for buildings set within a suite of other sectoral targets. With the publication of its latest Climate Action Programme, the German government has also set specific GHG reduction targets for the building sector by 2030, of around 66-67% relative to 1990 levels.

Achieving the 80% reduction target by 2050 will have significant consequences for the gas grids, particularly as non-fossil gas sources are often regarded as more appropriate to transport than heating. In 2011 natural gas accounted for around a third of household heat energy (Prognos AG) and the German government has not set a "phase-out" date for gas in buildings. This perhaps reflects more general political commitments:

> *We want to create incentives, not order compulsory renovation. Economic incentives are at the heart of our policy, not telling our citizens what to do (Energiekonzept 2010).*

Nonetheless, Germany has adopted relatively rigorous energy performance standards both for new buildings and for buildings undergoing renovation (a measure promoted by the EU Energy Performance of Buildings Directive (Mallaburn & Eyre 2013)). Performance standards enforced under the regulations are limited by the legal requirement they be "economically viable" (meaning

upfront costs should be lower than discounted savings over a 20 year period as seen from the building occupant's perspective; by contrast, UK Government guidance on valuing energy efficiency takes a macroeconomic perspective, and by stripping out fixed costs of energy networks leads to lower levels of energy efficiency being deemed optimal). However, this is not calculated on a case-by-case basis (so is not equivalent to the UK Green Deal's "Golden Rule"), but applies to broad categories of building.

Policymakers see stretching performance standards for new buildings both as ensuring a steady path to near-zero energy new buildings required by EU directives from 2019/2021 (public/all buildings) and as avoiding future retrofit requirements. Tightening of building standards occurred in 2016, 2009 and 2007. Enhanced KfW support is available for new build and retrofits that go beyond regulated minima as a means of supporting innovation and cost reduction creating both domestic and export benefits. KfW advanced standards are set relative to standards set out in the EnEv (e.g. 30% lower energy demand) and are broadly aligned with expected future iterations of the EnEv.

Communication

In the public press release for the Energy Efficiency Strategy for Buildings, the German government appealed to citizens to 'play their part' in achieving the 'common' target of a carbon neutral building stock by 2050. In addition to drawing on such notions of shared responsibility, the targets have been framed in the context of broader economic and environmental benefits, with an emphasis on a double dividend for citizens who can save both money and the environment.

Minister of Energy Sigmar Gabriel noted that the targets were ambitious yet achievable; in an official communication, he stated that 'I am happy to report that our renewable energy targets for 2020 may even be exceeded. With this new strategy we are showing citizens what still needs to be done to achieve a carbon-neutral building stock by 2050.'

Stakeholder forums and policy consultations enabled citizens to understand the challenges and trade-offs of decarbonisation and ultimately help shape policy. To this end, the government established the Buildings Platform in 2014, which brought together relevant stakeholders from commerce, civil society, academia and government ministries to feed into what was called a 'holistic' strategy for decarbonising buildings by 2050. A series of plenary sessions allowed stakeholders to submit hundreds of proposals on how to achieve the 2050 target, including quantifying the expected contribution from the various policy measures and incentives. Expert Working Groups were subsequently established to analyse specific issues in greater depth (e.g. the 'Advice and Information' Working Group tackled the issue of developing tailored advisory services for households, companies and municipalities). Focussing on ways to achieve the 2050 targets in the most cost-effective and efficient way formed the common thread throughout this consultation and engagement process.

In encouraging citizens to make efficiency improvements, the German government follows the slogan: "Supply information – Provide support – Demand action". As noted in the NAPE,

> *"energy efficiency policy is still founded on information, communication and advice. Information and advisory services will raise awareness among all energy users... Only well-informed citizens and companies will be able to take long-term decisions that result in higher energy efficiency and individual energy cost savings."*

To this end, the government has supported a number of initiatives to communicate the benefits of renovation and renewable energy installations for homeowners and businesses (see appendix). In many cases it has done so using public private partnerships (e.g. through the Deutsche Energie Agentur, or DENA), or in partnership with industry associations.

In most cases, these initiatives are focussed on benefits – e.g. the cost savings, added value, and environmental benefits of efficiency measures. Information sites and brochures tend to emphasise the amount of subsidy available, rather than the total cost to the consumer. As such, discussions of trade-offs are usually absent.

One function of communication initiatives is to help navigate the large number of incentive schemes organised by different levels of government and applicable to different circumstances. This may be indicative of a funding landscape that is congested; but it also shows that support is tailored to specific targets and particular types of building owners2.

A specific Federal government attempt to incentivise debt-averse homeowners to invest in energy efficiency illustrates the trade-offs across different levels of government, which in this case has led to deadlock. The Federal proposal was to allow households to claim costs of energy efficiency measures against their income tax. Estimated abatement was 2.1m tCO2e by 2020 (BMWi 2014). However, two attempts to introduce the measure were blocked by different Länder each citing negative consequences for their tax revenues from the different designs proposed. (The first objection was to lost income tax revenue. The Federal government included a compensation mechanism in its next attempt to pass the legislation, and this was the basis of (other) Länder's objections.)

Context-specific factors

Surveys in Germany reveal a consistently high degree of concern about climate change (Eurobarometer 2015 survey) and high levels of support for the Energiewende (A 2016 opinion poll conducted by an association of energy industries found 93% of the population consider the Energiewende to be important or very important). A relatively high proportion of the German population regard climate change as among the most serious problems facing the world. One component of popular support for the broad objectives of decarbonisation is the inclusive design of support for renewable electricity generation which is more favourable to individual, cooperative and municipal investment than UK support mechanisms (Hall, Foxon, & Bolton 2016). Anecdotal evidence suggests low carbon technologies have become part of conspicuous consumption in Germany, with solar panels or heat pumps taking the place among affluent Germans once held by a BMW or Mercedes in the front drive.

Germany has three distinct levels of government: the Federal government, Länder (states) and local authorities. Alongside federally funded programmes, Länder and local authorities engage in various forms of promotion and support for energy efficiency and renewable energy supply that are tailored to local circumstances and priorities. Where local measures are adopted, a priority is often placed on improving publicly owned buildings, both for the contribution energy saving can make to public budgets, and as a means of showing leadership in climate protection. In addition, Germany's financial sector is more distributed than the UK's, with a large number of Savings- and Cooperative-Banks dedicated to specific geographical areas (Hall et al. 2016). KfW finance is channelled through this networks of banks which are able also to signpost additional local and regional support measures.

[2] For example, a subsidised energy efficiency loan may be attractive to a young family moving in to a home they anticipate occupying for many years, whereas an older occupant of an inefficient building may be less attracted to long term debt.

Macroeconomic analysis of energy efficiency support finds KfW programmes make net positive contributions to public budgets, with €1.4bn spending generating between €6bn and €17bn3. This is principally due to sales and income taxes raised from subsidised activities, as well as reduced social security payments through job creation (Kuckshinrichs, Többen & Hansen 2015). Funding for these programmes is allocated from the federal budget, but generates benefit across all levels of government, particularly the Länder. These effects reflect the high labour intensity and low levels of imports associated with energy efficiency.

Conclusions

- Germany used system-wide modelling to develop sector-specific targets, including an 80% reduction in non-renewable primary energy demand by 2050.
- Extracting a target from an economy-wide model allows integration with other aspects of the energy system (e.g. the infrequent use of fossil-fired power stations to fill gaps in renewable electricity could also provide heat). However more refined analysis was required to map the possibilities for achieving the 80% buildings target and this found that nearly the full potential for both energy efficiency and renewable heat would be required.
- Converting the building stock to be "climate neutral" demands a wide variety of interventions. As well as fitting the right technologies to the right buildings, policies need to be tailored to be attractive to different constituencies.
- While support for the goals of the Energiewende is high, and in spite of a wide array of initiatives, the annual rate of energy efficiency retrofit remains stubbornly difficult to raise from 1% to 2%.
- The balance of powers/competencies across local government, the Länder and the Federal government means a large number of measures have been put in place, allowing for some policy innovation and targeting, but perhaps also leading to an excessively complex funding landscape. Relationships across multiple levels of governance have also stymied a policy whose advocates saw it as an important means of reaching households currently not attracted by low cost loans.

Appendix: Selected Energy Efficiency Communication Campaigns

Title	Sector	Sponsor	Description	Website
Efficiency Networks Initiative	Businesses	Federal Ministry of Economic Affairs and Energy (BMWi)	Platform for industry to cooperate and build local networks sharing ideas and resources for improving energy efficiency.	www.effizienznetzwerke.org
Energy Consulting	All	Federal Office for Economic Affairs and Export Control (BAFA)	Energy efficiency consulting for SMEs, Local Municipalities and Private Households, providing individual refurbishment plans.	www.bafa.de/DE/Energie/Energieberatung/energieberatung_node.html
House of the Future	Households	German Energy Agency (DENA)	Information portal for energy efficiency projects, including a list of experts and funding sources.	www.zukunft-haus.info/startseite.html

[3] The wide range of fiscal benefits reflects the range of assumptions that can be made, e.g. about additionality and employment impacts.

Electricity Savings Check	Households	Federal Association of Energy and Climate Change Agencies (EAD)	Impartial energy advice to households, plus energy-saving devices for low-income households free of charge.	www.stromspar-check.de/
Home Transition	Households	Energy Efficient Building Alliance (GEEA)	Technical information on technologies available to improve efficiency.	www.die-hauswende.de/
Energy Funding Database	All	BMWi	A database for specific funding sources, including local and regional initiatives.	www.energiefoerderung.info/
Germany makes it efficient	Households	BMWi	Country-wide citizen's advice and information portal for efficiency initiatives.	www.machts-effizient.de

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Case study 2: Strategy for heat - The Netherlands

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March 2017

Policy Description

Heat policy in the Netherlands is currently going through a transformation. The starting point for this visioning process was the 'Energy Agreement for Sustainable Growth' in 2013 (SER), a collaborative agreement between 47 stakeholder groups (government, industry, third sector and trade unions) setting out a long-term perspective for energy and climate policy. The Dutch government subsequently published a Heat Vision in 2015 (Ministerie van Economische Zaken) and Energy Agenda in 2016 (Ministerie van Economische Zaken) to complement the Energy Agreement. Combined, these documents set out long-term priorities and a vision for the energy system to 2050, although concrete policies and implementation mechanisms are largely still to be formulated. While the government has implied that Dutch society, and thus its buildings stock, will need to be (nearly) carbon neutral by 2050, it has not made an explicit commitment to phase out natural gas[4] (Ministerie van Economische Zaken 2016). With parliamentary elections coming up in March 2017 it will be up to the next government, as well as local and regional authorities, to transform the current government's ambitions and visions into concrete policies and proposals.

This case study focuses on domestic heat generation and demand reduction, although there are connections to other industries, particularly regarding the use of waste heat. Policies and proposals relating to domestic heat can be categorised into 2 pillars, demand reduction and stimulating low-carbon heat generation:

	Reduce heat demand	**Stimulate low-carbon heat generation**
Implemented	Tightened energy performance requirements for social and private rental sector. (Rijksoverheid n.d)	Renewable Energy Stimulation Scheme (primarily aimed at larger energy installations). (IEA 2012)
	Encourage homeowners to install further energy saving measures through subsidies, low-interest loans and an information campaign. (Rijksoverheid 2016)	Investment Subsidy in Renewable Energy (ISDE): financial incentive to stimulate the uptake of solar thermal, heat pumps and biomass boilers. (RVO n.d)
		Energy taxation change: shifting tax burden from electricity to gas in order to stimulate uptake of heat pumps. (ECN 2016)
Proposed		No gas connection for newbuilt neighbourhoods. Replace mandatory gas connection with a 'right to heat'

[4] Despite reports which implied that these are concrete targets (e.g. http://energypost.eu/dutch-government-evs-hydrogen-cars-2035-phase-natural-gas/)

		from 2018 onwards. (Ministerie van Economische Zaken 2016)
		Reform the heat market so that it emulates markets for gas and electricity in order to stimulate development of district heating. [5] (Ministerie van Economische Zaken 2015)

Table 1: Current and proposed heat policies

Targets

Background: In 2012, heat demand accounted for approximately 55% of all energy use in the Netherlands (SER 2016) 29% of heat demand came from households (Ministerie van Economische Zaken 2015). Whilst the Government expects demand to decrease, it expects these reductions to be moderate in the next 10-15 years. (Ministerie van Economische Zaken 2015). In 2013, only 3% of all heat came from renewable sources, and an additional 5% was provided by utilising waste heat (Ministerie van Economische Zaken 2015). Whilst currently 93% of homes are heated by natural gas, researchers expect[6] this to decrease to 90% in 2020 and 85% in 2030 as more homes will be heated through heat pumps or district heating, as a result of the policies above (ECN 2016).

Targets

The transition to a more sustainable heat system is currently largely under development. The targets which are currently in place are largely guided by EU, rather than national, policy. Until 2023 the Dutch Government has specific targets for renewable energy (Table 2). Beyond 2023, the Government has decided that GHG emission reductions should be the guiding principle for Dutch energy policy, and it has not set a separate renewables target (Ministerie van Economische Zaken 2016).

In order to reduce its CO_2 emissions by 80-95% by 2050 to meet its European commitments, the Dutch Ministry for Economic Affairs wants heating in buildings to be 'largely free[7] of CO_2 emissions' by 2050 (Ministerie van Economische Zaken 2016). Whilst this means that the use of natural gas in domestic properties will need ot be phased-out, concrete targets and policies are yet to be developed. Where specific targets have been set, these primarily focus on energy saving in buildings. These are guided by the EU's Energy Performance for Buildings Directive and the 2013 Dutch Energy Agreement, and have been established in collaboration with key stakeholders (RVO 2015).

Building targets

- From 2020 all new buildings to be almost energy neutral (Ministerie van Economische Zaken 2015). Requirements for what constitutes 'almost energy neutral' vary per property

[5] The 2014 Heat Act introduced legislation that sets a maximum price for heat, to ensure customers connected to district heating network do not pay more than if they were connected to the gas network.[5] The Dutch Government now wants to introduce further reforms.

[6] Note: these are expectations, not targets.

[7] There appears to be no concrete quantification of the 'largely CO2-free' aim

type. For dometic properties this means a maximum heat demand of 25kWh/m^2/year, maximum use of fossil fuels of 25kWh/m^2/year, and minimum use of renewable resources (50%), to be enforced through Building Standards[8] (RVO n.d)

- All existing domestic rental stock to be at an average EPC 'B' rating[9] for housing corporations (Netherlands Enterprise Agency 2015), and minimum of 'C' for private rental sector by 2020 (Netherlands Enterprise Agency 2015)
- 300,000 existing buildings (domestic and non-domestic) to be improved yearly by two EPC rating steps (e.g. C → A) (Netherlands Enterprise Agency 2015, SER 2015)

Built environment

The current government wants to combine building targets with area targets and regulations, the latter for example focused on the use of waste heat. The Dutch Government expects local and regional authorities to take the lead in this (Ministery of Economic Affairs of the Netherlands 2016). In Amsterdam the local authority has developed a strategy to phase out natural gas by 2050 and has signed an agreement with distribution network operators, heat companies and housing associations in order to achieve this (Gemeente Amsterdam 2016).

How far have targets been achieved?

	Starting point (year)	Achieved	Target
% of gross energy consumption from renewable sources (ECN 2016)	1.6% (2000)	5.8% (2015)	14% (2020) 16% (2023)
% of gross heat consumption from renewable sources (ECN 2016)	2.2% (2004)	5.5% (2015)	9% (2020)
GHG emissions reductions (compared to 1990 levels) (ECN 2016)	-	12% (2015)	16% (2020) 40% (2030) 80-95% (2050)
Gross final energy consumption (PJ) (ECN 2016)	2257 (2000)	2076 (2015)	2047 (2020)

[8] In practice, this means houses need to be carefully designed (size of a house's footprint makes a significant difference), require high levels of insulation and one, or often multiple renewable energy technologies.Two examples in English can be found here (p.55-58), further examples in Dutch can be found here.

[9] Different countries have their own metrics for measuring efficiency, including different variables. A 'B' label in the Netherlands may not necessarily be the equivalent of a 'B' label in Scotland/UK.

Average energy index10 rating public housing (ECN 2016)	1.78 (EPC label C) (2011)	1.61 (EPC label C) (2015)	1.25 (EPC label B) (2020)
Minimum energy index new build homes (Rijksoverheid n.d)	0.6 (EPC label A++) (2013)	No data, but interim target of 0.4 (2015)	Near 0 (EPC label A++)
% of privately rented homes EPC rating 'C' or above	No data found	No data found	80% (2020)

Table 2: Relevant targets and timescales

As this table shows, the Netherlands is still some way off meeting many of its energy targets. It is expected that energy consumption targets for 2020 will be met. It currently seems unlikely, however, that the 2020 renewable energy targets will be met. There is a chance that the 2023 renewable energy target can be met due to an expected increase in renewable energy deployment in coming years (ECN 2016). There are concerns that arrangements made with housing corporations at the local level are insufficient to meet the public housing energy efficiency target (ECN 2016).

Timescales

What is the timeline for the transition?

Three main deadlines were identified for the Dutch heat transition:

- 2020: A statutory deadline for the all targets listed above.
    - The only interim aim identified regards the efficiency of new-built homes (identified in the table above).
- 2023: An additional (non-statutory) deadline for renewable energy generation (16% of gross consumption) which emerged out of the 2013 Energy Agreement (Kamp, H 2016)
- 2050: Deadline for EU –set target of 80-95-% reduction in GHG emissions. The Dutch government has said that this means buildings will need to be near-carbon neutral. There are currently, however, no statutory deadlines, interim milestones or measurement criteria for switching off gas or the implementation of other measures to achieve this.

How has the timescale been set?

Timescales have been set in a number of ways. Most derive from EU legislation, although the content of the targets have been set through collaborative processes with stakeholders and public consultation.

Building targets are driven by EU directives, with the specifics drawn up in agreement with housing corporations representative and the private rental sector (Rijksoverheid 2012)

The Dutch Government has set up a 'Heat Table', consisting of three working groups made up of Ministers from different departments, local and regional authorities, and the private sector to

[10] The 'energy index' concept is a new way to calculate the energy efficiency of homes. The key difference with earlier calculations of the EPC rating is that the energy index on a much larger number of characteristics (150). The numerical rating reflects the efficiency of a property in a similar way that the A-G scale in the UK does. In this case, a property with a rating of 0 is energy neutral.

transform these long-term visions into more concrete proposals. The next government will be responsible for transforming these into policies and timescales (Schokker 2016)

Communication

Approaches to communicating challenges and policy trade-offs

The main innovative approach that has been tried has been an 'Energy Dialogue', organised by the Dutch Government, which took place over a period of three months in 2016. The aim was to engage citizens in the question of how to further the energy transition between 2023 and 2050 (Rijksoverheid 2016). This dialogue took place both online and offline, on a designated website, social media and during 150 'offline' events (Rijksoverheid 2016). As the dialogue only concluded in September 2016, it has been difficult to identify results of, or feedback on, this process.

General reactions to proposals for heat:

In 2013 less than 9% of heat came from renewable sources or by using heat from waste (Ministerie van Economische Zaken 2015), but here appears to be broad agreement for the need to decarbonise heat (including from the gas industry). This headline from the Algemeen Dagblad newspaper appears to reflect the national mood quite well: 'A Netherlands without natural gas? We'll have to!'.

Particularly, ongoing problems with natural gas extraction have helped make the issue of heat more tangible for three reasons. First, most of the natural gas is produced domestically, but an estimated 80% of reserves have been exploited. The government is reluctant to increase gas imports for both economic and energy security reasons (CBS 2016). Additionally, there has been a growing public disapproval of domestic gas extraction due to a number of earthquakes in recent years, which have been attributed to gas extraction (Crezee, B. 2016; BBC 2013). Finally, in many Dutch cities the gas network needs modernising. Given the two factors above there is general agreement among politicians and the public this is a good time to consider alternative options rather than invest in updating current gas network (Rijksoverheid 2015). As a result of these drivers, the government has limited gas extraction 24 billion m3 per annum from 2016 onwards11, with the majority of political parties indicating they would like to see an even greater reduction (Financieel Dagblad 2017).

The recent approach to heat is one of establishing long-term visions and agendas, without committing to specific targets, interim aims or implementation strategies. This can possibly be (partly) explained by the upcoming parliamentary elections, which may have contributed to a situation where the current government wanted to be seen as taking action, without entering into long-term commitments (Musch, S. 2016). Nonetheless, this has resulted in criticism from other political parties (including the junior coalition party), and commentators from both industry and non-governmental organisations that current agendas and reports are 'full of vision' but contain few concrete measures for practical implementation (Duurzaamheid.nl n.d.; NRC 2016, Natuur & Milieu 2016; NVDE 2016; De Ingenieur 2016; De Telegraaf 2016). As a result (and as part of the ongoing election campaigns) five centre-left political parties have stated they would support a new Climate Act, which would set out legally-binding targets and deadlines until 2050 (FluxEnergie 2016). The five parties argue that such an Act is important to 'depoliticise' Climate Change by introducing long-term statutory obligations (Van Raaij, B. en Reijn, G. 2017). Interistingly, the Act has also gained the support from industrial stakeholders, including energy companies such as Shell, who say they would benefit from clear and consistent long-term policies (Cats, R. 2017).

[11] Down from a peak of 52 billion m^3 in 2013

Whilst there have been calls for more concrete measures, the general public appears wary of heat networks[12], the potential for cost increases, and measures forcing homeowners to make their homes more energy efficient (Energeia 2015). This general support for decarbonisation of heat, but disagreement or concern about possible measures, may help explain why the current government has indicated it is the responsibility of the next government and local authorities to introduce more concrete policies and mechanisms. The lack of concrete plans from the government may thus obscure underlying tensions and policy trade-offs.

Context-specific factors

How were policy trade-offs addressed and why?

Regarding the areas in which specific targets are still to be formulated, there has thus far been a relatively broad consensus regarding the direction of travel. Three main reasons for the limited opposition were identified. Two of these have been discussed above: the lack of clarity for the direction of travel and identification of a shared problem (the issues with natural gas). The third is the consensus approach to finding solutions.

Consensus approach to identifying way forward: The current Government has been reluctant to introduce statutory obligations, preferring a collaborative approach to formulating targets and approaches. The 2013 Energy Agreement was formed through cross stakeholder deliberation, ensuring that it set out a direction which was largely acceptable to most/all major players. Subsequent developments such as the 'Heat Table' described earlier take this collaborative approach forward. In order to take heat policy forward, the Ministry of Economic Affairs established a 'Heat Table' in 2016 to bring together Ministers from different departments, local and regional authorities, and the private sector with the purpose of turning the government's Heat Vision into regulation, implementation and concrete projects (SER 2016). Academics have expressed concerns, however, that the involvement of key incumbent actors in driving the energy transition means that they set the tone of the debate, at the detriment of new/other stakeholders and more radical visions (Joop 2015).

Push-forward: Despite the collaborative approach and the general acceptance for the need to reduce reliance on gas, there has been some push back from stakeholders with more radical visions. In 2015 the Urgenda Foundation[13] took the Dutch State to court. The case ended in Urgenda's favour, as a result of which the government has to reduce GHG emissions by 25% in 2020 compared to 1990 levels, rather than the 16% reduction target initially set by the Dutch Government (ECN 2016). Unless overturned (the government is currently appealing the decision), this 'hard' target is likely to drive further policy changes (ECN 2016).

What key factors made the policy work and what lessons can be learned?

The identification of a shared, tangible problem (the problems with natural gas extractions) has been one key factor to increase acceptance for decarbonising heat. The second key factor which appears to have helped the Dutch government move forward with its heat policy is the inclusion of other levels of government as well as societal and industry stakeholders in developing a heat strategy from an early stage.

The Netherlands has a history of adopting a consensus-approach to decision making (Wikipedia n.d.), and has also adopted this approach to develop a general direction for energy policy. The

[12] In 2014 4.5% of homes were connected to heat networks. This is expected to increase to 5% by 2020.

[13] Urgenda is an independent third sector organisation for sustainability and innovation, founded in 2007 by two researchers.

Dutch Ministry for Economic Affairs (responsibly for energy policy) has argued that it is not 'able or willing' to be solely responsible for making fundamental changes to provisions to heat supply (Ministerie van Economische Zaken 2015). It has therefore called on other stakeholders to contribute to a joint-approach, in which the Ministry of Economic Affairs plays a coordinating role. The Government's position is that decisions on the organisation of the heat supply are best made at the local level, based on local conditions and preferences (Ministery of Economic Affairs of the Netherlands 2016). It thus foresees a greater role for local authorities, but also building managers, property developers and residents. Starting point will be a regional heating plan to be developed by regional authorities (Ministery of Economic Affairs of the Netherlands 2016). The national government sees its role as supporting: reviewing policy and market rules for the supply of energy and maintenance of infrastructure (Ministery of Economic Affairs of the Netherlands 2016).

Conclusions

- In 2016 the Dutch Government set out its long-term vision for a (nearly) decarbonised domestic heat sector by 2050.
- 2020 – 2023 heating sector decarbonisation targets primarily focus on energy saving in buildings.
- Policies for 2023 – 2050 are yet to be developed.
- Decreasing natural gas resources and problems with gas extraction lead to a widespread support for decarbonisation across the political spectrum, civil society and industry.
- Stakeholders from different sectors (from industry to NGOs) as well as various political parties are currently pushing for more concrete decarbonisation targets. This may, however, create tensions around the underlying policy trade-offs visible, which have thus far been largely obscured by the lack of concrete proposals.
- Going forward, the Dutch Government has thus far adopted a collaborative approach. It is currently involving industry stakeholders and other levels of government in the development of a broad strategy for a heat transition.
- The Dutch Government sees its role as a coordinating one, with local and regional authorities taking the lead in collaboration with other stakeholders.

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Case study 3: Climate Change and Energy Strategies / Plans / Policies - Sweden heating policies

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February 2017

Policy Description

The Swedish heating system primarily relies on district heating networks supplied by small scale power plants. The main policy drivers for the decarbonisation of heating are fossil fuel and CO_2 taxation combined with tax reduction and subsidies for preferred technologies. Since the 1970s Sweden has achieved impressive CO_2 intensity reductions and increased energy efficiency with continued support for research, development and deployment of new low carbon technologies, most notably combined heat and power (CHP) plants and biomass fuels.

The heating of space and hot water in buildings is dominated by largely biomass-fired district heating schemes for multi-dwelling residential houses and non-residential premises, while detached houses are most commonly heated by heat pumps and electric heaters. CHP plants in district heating systems are supported by various subsidy programmes and tax reduction schemes, both of which heavily favour biomass and municipal waste fuels. A ban on landfilling burnable and organic waste incentivised waste-to-energy plants (SEPA 2005). A wide range of research and development programmes, favourable loans for household-level investment and information campaigns have helped to establish heat pumps in the single-dwelling market (Kiss et al. 2012). Finally, efficient use of energy is ensured by Energy Performance Certificates and Building Regulations, which require strict energy efficiency standards and limit energy use in new buildings to 90 kWh/m^2. Grants, subsidies and tax reductions are available to progressively upgrade old buildings to this standard. Information campaigns on energy efficiency in the residential sector were designed to inform the public about new regulations and demonstrate technological solutions.

Targets

In February 2017 Sweden committed to completely phasing out all greenhouse gas emissions by 2045. Sweden is set to publish the full legislative proposal in the coming months which will come into action in 2018. Government will establish a climate action plan every four years which will be overseen by an independent advisory body. The idea was initially proposed by the socialist and green parties and backed by a coalition of seven out of eight parties across the political spectrum. The leader of the working group on potential climate law cited the UK's Climate Change Act as one of the major influences for the Swedish cross-party agreement. The UK Climate Act, which was passed unanimously in 2008, encouraged the Swedish conservative parties to lend their support to the new legislation. Despite the political differences, members of the current coalition were willing to compromise and reach a united target for this highly publicly-supported issue.

Heating policy in Sweden sits under the overarching cross-sectoral EU Energy Efficiency Directive (2012/27/EU) with a broad goal of reducing energy intensity by 20% by 2020. In addition, Sweden aims to completely phase out fossil fuels in heating by 2020. The key domestic objectives that have shaped Sweden's heating policy landscape can be summarised as:

- Reduce the dependence on oil
- Reduce CO2 emissions
- Utilise waste heat from electricity generation and industrial processes
- Increase energy efficiency in buildings.

The incentives for renewable energy use are supported by taxing CO_2 and fossil fuels as opposed to using different feed-in tariffs or mandates. Fossil fuel and CO_2 taxation was introduced in 1991 and periodically increased to a current level of £107 (1200 SEK) per tonne of CO_2 being the highest in the world. The tax structure comprises an energy tax, a CO_2 tax and a sulphur tax. CO_2 tax is based on the carbon contents of all fuels with exceptions of biomass and peat. The maximum level of tax is applied to individual consumers, while the industry and service sectors receive varying tax exemptions. This means that energy-intensive industries are encouraged to implement technological change, while less intensive industries are not unfairly burdened and remain competitive internationally. Currently this tax only applies to industries which do not participate in the EU Emissions Trading System (EU ETS).

In line with this, Sweden does not have targets for specific heating sources/fuels or technologies, but rather provides a package of support for district heating, by-product heat utilisation schemes and heat pump use, along with investments in technology development. The major expansion of CHP plants was supported by two stages of subsidy programmes, the second of which directed 50% of funds to biomass-fired plants. Following the landfill bans of burnable waste, a waste-to-energy tax was introduced to the already established waste incineration industry to favour CHPs over heat-only plants. Tax reductions based on whether incineration facilities produce electricity encouraged further expansion of waste-to-heat CHP plants (Jacobsson 2008). District heating is a natural monopoly where individual power plants cannot effectively compete across the network due the localised nature of the technology, therefore policy instruments like subsidies or selective taxation are effective in promoting the preferred type of generation.

Timescales

Since the 1970s Sweden has increased its district heating capacity by 77% (14.6 TWh to 62.6 TWh), while the associated CO_2 emissions remained stable (fig. 1). This has been achieved by diversifying fuel types and phasing out fossil fuels, which currently account for 14% of the supply and are on track to be completely phased out by 2020. The district heating market is mature and not expected to grow considerably because of increasing building efficiency standards and low new housing construction rates. Biomass and waste-heat market shares will continue growing until 2030 (IEA 2013), although growth potential for waste-to-heat is limited given that Sweden is already importing waste for incineration. Investment support schemes for solar heating were introduced in 2011, but the programme was discontinued after solar heating proved to mainly outcompete already low-carbon district heating and heat pumps (SMEE 2014). Further emission reductions will be achieved through replacing old power plants with more efficient CHPs and decreasing energy demand (Ericsson & Werner 2016).

CO_2 emissions in commercial and residential individual heating sector have dropped from 9 TWh to 2 TWh since 1990 (fig. 1). Electric heaters and natural gas boilers are still in the market, so further heat pump deployment is expected to decrease the emissions (Kiss et al. 2012).

Figure 1. a) CO2 emissions from district heating have remained stable from 1990 to 2011. Heat pump deployment supported by government policy programmes (marked red) lead to a significant emissions decrease in individually heated premises. b) District heating capacity increased from 14.6 TWh in 1970 to 62.6 TWh in 2013. Biomass became the dominant fuel along with the expansion of waste heat and heat pumps, while fossils fuels are being phased out. Data from (SMEE 2014; SEA 2015)

Communication

Sweden actively advocates for more ambitious CO_2 emission reductions targets and higher EU ETS trading price in the EU to match its own progressive domestic policies (Williams 2015). Positioning itself as a global leader in sustainable growth, Sweden runs highly publicised information campaigns about its domestic policies which often go viral. A notable example is the recent photograph of the Deputy Prime Minister Isabella Lövin signing one of the world's most ambitious climate laws surrounded by all-female cabinet members. Lövin used the publicity to encourage European countries to take leading roles in climate action and remind China and India of their Paris commitments. Another example is the waste-to-heat information campaign, which went viral announcing Sweden only landfilled 1% of its domestic waste.

The Swedish public has been supportive of environmental policies, largely due to the Swedish government efforts to increase the amount of accessible information and common political-cultural understandings of the Swedish welfare state and equality. Swedish municipalities have local energy advisers who provide information about building standards and low carbon technologies and practical information on house improvement. Educational campaigns combined with home improvement subsidies were instrumental in preparation for the 1991 CO_2 tax to avoid public push-back and an unfair tax burden for low-income households (Sprei & Holmberg 2006). 'Become Energy-Smart' campaign ran in 2006 – 2009 and included an exhibition of 'The Energy-Smart House' which visited several cities in Sweden. The campaign provided information on energy saving at home. Among other materials, the campaign distributed energy calculators designed to estimate investments needed to reduce energy requirements in single-family dwellings (SMEE 2014).

In an attempt to improve the public trust in heat pump technology, the government increased investment in research and development and certification programmes. Sweden hosted the International Energy Agency's Heat Pump Centre and other international knowledge exchange initiatives. Investment in research combined with public information campaigns strengthened the market and consumers' trust (Kiss et al., 2012). Currently Sweden is Europe's leading heat pump manufacturer and supplier and has a much higher domestic heat pump take up rate than its neighbours such as Finland. Bayer et al. (2012) suggests that heat pumps are favoured by the public because the extensive research and manufacturing have taken place in Sweden. This example indicates that individual consumers may favour and support locally developed technologies over competing imported alternatives.

Context-specific factors

Sweden's district heating and heat pump development has been influenced by contextual factors such as availability of biomass, lack of fossil fuel reserves and a strong tradition of municipal ownership. Other key factors like policy stability, strategic use of taxation and subsidies, investment in research and development programmes and information campaigns are relevant in other contexts, such as Scotland.

Local resources

Sweden has no natural oil and gas resources and very limited connectivity to a natural gas grid but has widespread and highly productive forests. The availability of cheap biomass fuel and the lack of

national fossil fuel reserves were the key factors favouring the expansion of biomass-fired district heating schemes. Clearly, here the Scottish context is different, with an extensive gas network and relatively cheap gas prices.

In 1970s Sweden's district heating system was fully reliant on imported oil. Oil price volatility had a direct impact to consumers and business during market fluctuations associated with the 1970s oil crisis. Numerous government policies to introduce biomass in district heating systems were welcomed favourably by the public (Nykvist & Dzebo 2014). The Swedish pulp and paper industry generates large quantities of by-products which were previously unused. The introduction of biomass to district heating created a new market for forestry waste and offered an opportunity for economic growth. However, the competition for forestry resources is projected to grow in the future from new applications for biomass in the production of transport fuels, chemicals and plastics. Market researchers expect district heating systems to adapt and utilise the waste heat generated by these processes as opposed to directly use biomass as fuel (Ericsson & Werner 2016).

Sweden has historically enjoyed low electricity prices generated in hydro and nuclear power plants. Electric heating has been the most popular option in detached houses since the 1950s and is currently being replaced by a growing heat pump market (Nykvist & Dzebo 2014). Limited household access to a natural gas grid makes heat pumps preferable to gas boilers and less efficient electric heaters.

Policy stability

CO_2 and fossil fuel taxation was introduced in 1991 and has been a stable policy instrument since. No specific emissions targets for heat were set, rather allowing households and businesses to respond to the price signal by implementing their choice of technologies and strategies. The key strength of the policy has been its stability despite changing governments and efforts made to announce any regulatory changes well in advance allowing businesses to adapt accordingly. Business and other stakeholders are involved in decision making via consultations on government proposals before these are presented to parliament (Hammer and Åkerfeld, 2013).

The blanket ban on landfilling burnable and organic waste implemented in 2002 and 2005 provided a strong incentive for business to find innovative and cost effective technologies for waste incineration. Currently Sweden recycles or incinerates 99% of its own waste and imports more from neighbouring countries, which constitutes 7% of total fuels used in district heating (SEA 2015).

In contrast, several authors indicate that fragmented subsidy programmes for heat pump deployment in the early 1980s and 2000s undermined the market stability achieved by carbon tax and discouraged long-term investment. The overall programme achieved success, but economies of scale in production, borehole drilling and technology improvement were arguably more important factors than the subsidies (Kiss et al. 2012; Nykvist & Dzebo 2014).

Community ownership of property and infrastructure

One of the main reasons for district heating expansion was the large affordable housing construction programme known as the Million Homes Programme carried out from 1965 to 1974. This resulted in many new multi-dwelling houses suitable for centralised heating system. Owners of multi-dwelling properties have a share in the whole building rather than ownership of individual flats, which favours centralised heating schemes to individual boilers (Nykvist & Dzebo 2014). The Million Homes Programme is a case study of the relative ease with which district heating can be introduced in newly-built housing developments.

Municipally owned energy companies have traditionally been the main actors in district heating. These public companies own generation plant and the pipeline infrastructure and are responsible for heating distribution. Public companies can be expected to adapt and react to new government

policies quicker than private enterprises, which is an important factor in the early stages of district heat system decarbonisation (Johansson 2000). Following heating market deregulation in 1996 companies were allowed to act competitively and regulate their own prices. This resulted in energy price rises in densely populated areas which in turn opened up opportunities for competing heat pump technologies (Magnusson & Palm 2011). Although market deregulation has been controversial, the Swedish government succeeded in creating and supporting a market for district heating technology during its development and subsequently decreased state regulation once the technology reached maturity.

Conclusions

- Sweden has a target to phase out fossil fuels in heating by 2020.
- Sweden has no natural fossil fuel resources and limited connectivity to a natural gas grid, which has favoured biomass as the key fuel for district heating.
- Taxes on CO_2 and fossil fuels, combined with long term policy stability were the critical factors in enabling low carbon technology uptake and ensuring business stakeholders' trust.
- The CO_2 tax was combined with tax relief in different sectors, redistributing the taxation but not increasing the total amount.
- Biomass and waste-fired CHPs are supported with tax exemptions and subsidies.
- New district heating markets were established with sustained government support. When the market reached maturity, further technology development was encouraged through private sector competition underpinned by targeted tax and subsidy regimes.
- Further CO_2 emissions reductions in district heating are expected from increase in waste heat utilisation from industrial and chemical processes and energy demand decrease.
- In addition to relative cost, investment in domestic research & development was a key factor for high heat pump uptake.
- High building efficiency standards ensure low-income households are not penalised by fuel taxation.

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Case study 4 Decarbonising Transportation in The Netherlands – A Policy Case Study

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February 2017

Summary

This case study reviews the transportation decarbonisation policies of The Netherlands under The Energy Agreement for Sustainable Growth (EASG). The agreement was finalised after six months of negotiations between more than forty representative organisations and The Netherlands Government. The negotiating parties included representatives from labour unions, employers' associates, environmental organisations, finance groups, construction contractors, and government. The group concluded that The Netherlands should have a "full sustainable" energy supply by 2050.

The negotiations commenced after the end of six government cabinets in ten years. This political instability put The Netherlands at risk of breaching EU targets on decarbonisation and renewable energy. EASG sets out goals within twelve pillars of the Dutch Economy. The transportation decarbonisation targets are (1) a 60% sectoral reduction in emissions by 2050 compared to 1990 levels, and (2) a 25 Mt CO_2 reduction, or 17%, by 2030. The short-term policies largely take advantage of early momentum in electric vehicle (EV) uptake, while long-term policies are unclear and under development.

Policy Description

In the years prior to *The Energy Agreement for Sustainable Growth* (EASG), the Dutch government saw six cabinets (but not entire governments) in ten years. As a result of political instability and inaction, The Netherlands was in danger of missing their EU targets on decarbonisation and renewable energy. The coalition government of 2012 requested advice from the Social and Economic Council (SER) on climate and energy policy. The government was seeking an assessment of the economy's ability to adapt to climate change considering rising energy prices and reduced fossil fuel availability.

SER replied with a pledge to create a *National Energy Accord for Sustainable Growth*. The council, businesses, and NGOs informed Government that a unified energy and climate policy was needed for foster investment and long-term planning. On 16th November 2012, the advisory report *Towards an Energy Agreement for Sustainable Growth* was adopted at SER's meeting, and the conference leading to the agreement began.

On 12th July 2013, an outline agreement was reached before Parliamentary recess. Six weeks later, on 28th August 2013, parties to the negotiations reached agreement on EASG. On 6th September 2013, after an eight month closed-door negotiation process, all forty seven parties to the negotiation signed the EASG. The EASG, comprising twelve pillars, outlines a number of long term targets for The Netherlands' decarbonisation pathway to reduce emissions by 60% from 1990 by 2050.

The Netherlands' Transportation Strategy falls under The Energy Agreement for Sustainable Growth.

Targets

Transportation decarbonisation is one of twelve pillars of the agreement. The Netherlands' Transportation Strategy set transportation targets for decarbonisation.

These targets are aimed at introducing sustainable and efficient transportation. The parties to the negotiations of EASG set two, high-level targets:

- 60% reduction in CO_2 emissions by 2050 (compared to 1990); and,
- 25 Mt CO_2 reduction (-17%) in 2030 en route to attaining the 2050 target.

Using the above targets, the stakeholders of the transport industry drafted a "green agenda". This agenda focused on twelve transportation industry specific key areas. The agenda noted the high–level targets (long term goals) agreed upon during the negotiations and formulated pathways to achieve these targets (short term measures).

These pathways centred around:

- sustainable fuel mix policy;
- EV charging stations, to be funded by public-private partnerships;

In addition to the high-level targets, the sector agreed on targets that would:

- Contribute to energy savings of 15-20 PJ by 2020 compared to 2012 baseline. For comparison, 1 PJ reduction is equivalent to the annual average electricity and gas consumption of 15,000 Dutch households.
- From 2035, all new passenger cars sold must be capable of running CO_2 emission free. (Sustainable Fuel Mix objective)

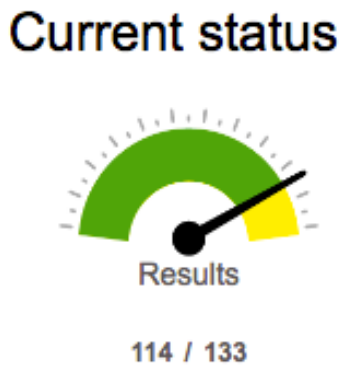
Timescales

The Standing Committee is the governing body of the EASG. It comprises all parties to the Agreement and is chaired by a former Minister for the Environment. For accountability, the group produces an annual progress report, a National Energy Report containing a policy assessment, formal evaluation of the Energy Agreement in 2016 (released in Dutch, English to follow), and facilitates further evaluation of policy mechanism.

Within the transport sector and separate from the "green agenda" paper, the Green Deal seeks to consolidate all previous and future Dutch actions on EV mechanisms until 31st December 2020. It will produce a review in mid-2018, with aims to conclude the policy at the end of 2020. Specific actions or policies for future sustainable fuels have yet to be established.

Communication

Progress is monitored on the BEN dashboard (see figure) for the public and participants. There are Annual progress reports, National Energy Report, a formal evaluation of the Energy Agreement was made in 2016. After the latest progress report, the EASG received criticism by green NGOs and left-leaning parties in Parliament as not being ambitious enough with decarbonisation targets.



Example progress meter on [BEN dashboard] for measuring progress on policy agreements under "The Energy Agreement for Sustainable Growth." Progress on individual policies is not measured. The metric chosen only show whether or not a policy exists.

Context-specific factors

No clear policy trade-offs were made, as the negotiations occurred behind closed doors with policymakers and involved organisations. However it is important to note that the discussions which led to the EASG was a response to industry demand. The Social and Economic Council (SER), businesses, and NGOs informed Government that a unified energy and climate policy was needed for foster investment and long-term planning. It is unclear which business & industry sectors were the catalysing sectors for the improved policy.

Sustainable Fuel Mix

A Vision on Sustainable Fuels for Transport provides the framework for achieving the transportation decarbonisation goals at a country-wide level. It was laid out after a consultation process involved over 100 organisations. The stakeholders represented fuel producers, vehicle manufacturers, energy companies, transport and shipping companies, local authorities, NGOs, and local knowledge centres. They agreed to bring forth a package of public and private measures that would ensure the decarbonisation goals are met, regardless of adverse economic conditions. To streamline discussion on reaching decarbonisation targets, the major transportation groups divided into six tables:

- Road transport-renewable liquid
- Road transport-renewable gaseous
- Road transport-renewable hydrogen
- Road transport-renewable electric
- Sustainable shipping
- Sustainable aviation

The six working tables reported back with specific action plans on how they will help support the EASG and transportation decarbonisation goals. Amongst other goals, they estimate that the Netherlands require approximately 3 million zero-emission vehicles by 2030. Passenger transportation and short distance freight transport are suitable for electric power sources from batteries or hydrogen fuel cells. These modes of transport receive the earliest action, because EVs

already have market penetration. In the long-term, significant research and development will be needed in biofuels and hydrogen fuel to make them market-ready.

The groups point to significant co-benefits to decarbonising the transportation sector. Cleaner air and quieter public transport will result from electrifying public transportation. Smart grid technology development will be aided by EV uptake, and foster innovation in The Netherlands' Universities, and smooth renewable energy storage.

There will be an employment shift from manufacture, maintenance, and support of internal combustion vehicles to similar industries surrounding EVs. However, EVs are more reliable than internal combustion vehicles, and will require less maintenance. This shift could be supported by a facility the size of Tesla's Gigafactory to capitalize on the €9.2 billion (2015) industry, and bring 6,500 jobs.

EV Charging Station Rollout

From 2011-2015, The Netherlands became a leader in electric vehicle transportation. The country has the second highest penetration of EVs globally. That success has also benefited employment, as the number of full-time jobs in the sector has increased fivefold in the five years leading up to 2013. CE Delft projects a further sixfold increase in full-time jobs from 1,600 in 2013 to 10,000 in 2020.

The Green Deal Electric Transport 2016-2020 seeks to consolidate all previous and future Dutch actions on EV mechanisms until 31st December 2020. It is assumed that no more financial incentives will be needed to grow the EV sector in The Netherlands after 2020. However, a review of the progress of the policies will be released in mid-2018.

There are various working groups which connect the parties and / or their members. Examples are: Big Wheels, Consumer, Communication, Light Electric Vehicles, Charging Infrastructure Plug-in Hybrid Electric Vehicle and Internationalisation. Beyond the working groups, further knowledge development will occur at three technical universities teaching about electric vehicles.

To achieve the growth of EV deployment through a consumer market, funding is available to improve the charging infrastructure. Living Labs will initiate research into smart charging and storage by EVs for the variable use of renewable energy to the grid improvement. This research initiative will provide space for leaders in the field of EV to redeem (international) earning potential.

Two additional EV targets were established: 200,000 EVs by 2020, and 10% of new cars will be EVs in 2020. There are currently 115,000 EVs utilising nearly 12,000 public and 14,300 semi-public charging stations. Of these 612 are fast chargers. There are a further 72,000 private charging stations in The Netherlands. This is a rapid improvement from the 5,800 public, and 7,200 semi-public charging stations in 2015.

In July 2015, the EU Commission approved a plan for the Netherlands to make available €33 million of public funds for installation and operation of EV charging stations. The plan falls under the Green Deal scheme for publicly accessible charging infrastructure. The scheme allows local authorities to choose their level and type of participation considering local needs. The public funding first comes from local authorities, and if private investment is secured, national-level funding is made available. The scheme will run for three years until 1st July 2018, with annual reviews.

The rollout of the charging stations quickly found further problems in costs. Four months after the initial plans, a constituent group convened to give a first assessment of the roll-out. The group consisted of representative local authorities, Government, EV station installers, and NGOs for EV transportation. The group concluded that existing EV stations are yet to operate profitably, and would need further investment from local and national government to meet 2020 targets. They proposed an additional €5.7 million of public funds during the three-year scheme. The funds would subsidised €900 per station in the first year to €300 per station by the end of scheme.

In addition to these funding issues, there have been legal issues. Fastned won a licence from the Dutch government to build 200 electric vehicle fast-charge stations. They contracted ABB to build the stations located "within 50 kilometres of all the country's 16.7 million inhabitants," and were challenged in court. Fastned's plan to build the charging stations next to petrol stations on highways was challenged by the association of petrol station operators. The association argued that they had an exclusive government permit to sell transport fuels at those locations. A judge ruled in favour of Fastned, and allowed the start-up to compete alongside the petrol stations.

Electric Public Buses

The Government set a 2025 goal of complete electrification of the public bus system. As of April 2016, only 52 of 5,000 public buses and trollies in the Netherlands on the electric grid, meaning The Netherlands are committed to replacing 99% of the public bus fleet in the next 8 years.

Electric Trains

The Dutch Government announced plans to entirely electrify its country's train system with wind power by 2018. Last month, Government announced they had achieved this goal a year earlier than expected. While this achievement is being celebrated as a triumph towards decarbonisation, it is also an important indicator of an efficient EU electric grid.

The Netherlands generates 7.4 billion kWh of wind power, compared to 12.5 billion kWh wind power demand. The train system is 10% of this demand, roughly equal to all the households in Amsterdam. To meet the gap in renewable supply, Dutch company Eneco, procures Guarantees of Origin for certificates of renewables. Therefore, this transportation decarbonisation goal was met by (1) improved wind farm capacity in The Netherlands, Belgium, and Finland; (2) a market mechanism which allows for purchasing and transmitting renewable energy across Northern Europe; and (3) efficient interconnection between EU nations.

Conclusions

- The Netherlands transportation decarbonisation policies under The Energy Agreement for Sustainable Growth seeks to reduce transportation emissions by 60% by 2050 (compared to 1990) with and intermediate goal of 25 Mt CO_2 reduction (-17%) in 2030. Decarbonisation targets were made because of government inaction, and industry desire for long-term policy.
- Full electrification of the train system was made possible by early completion of wind farms in Northern Europe.
- Transportation decarbonsation policies take advantage of early Electric Vehicle (EV) market penetration. The Green Deal helps facilitate EV infrastructure investment through public-private partnerships The Dutch government will look to close this mechanism in 2020, when they expect charging infrastructure will be sufficient and/or economical to support continued EV development.
- Transportation decarbonisation targets contain small policy changes in the short-term, and require further research for long-term goals. Pre-market technologies are being researched

at Dutch labs and universities. These future technologies will support current EV infrastructure which has seen rapid success thanks to regular industry-led consultations.

Case study 5: Electric Vehicle Policy in Norway

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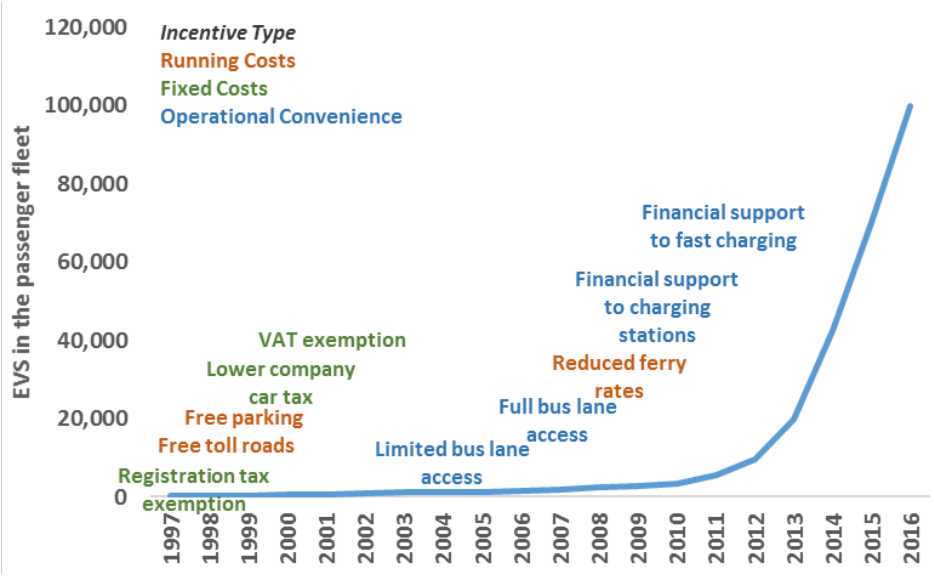
February 2017

Policy description

Norway has one of the most generous and long-running incentive structures for battery electric vehicles (BEVs) in the world. The Norwegian government's efforts in this area have been motivated by a desire to improve air quality, drive up the use of renewable electricity and reduce GHG emissions from the transport sector. Attempts to establish a domestic EV industry also initially furthered the government's national innovation and industrial development priorities.

There is no dedicated electric vehicle strategy or programme, but rather a series of policy interventions and programmes, variously contained in climate policy documents, national transport strategies and budget plans, that are designed to encourage uptake. Figure 1 shows the progressive evolution of incentives.

Fig. 1: BEV incentives and uptake in Norway



Efforts to commercialise Norwegian-made BEVs started in the 1990s, with the state financially and institutionally supporting domestic BEV manufacturing firms. The relatively high level of taxation on conventional petrol vehicles in Norway gave the government substantial leverage to encourage electromobility – through the exemption of BEVs from vehicle registration costs, the 25% VAT charge on new car sales, import duties, and company car levies. Government policy also widened beyond these 'fixed cost' incentives, with vehicles becoming exempt from road tolls and municipal parking charges, and eventually benefitting from reduced ferry prices and progressive access to bus lanes. In later periods of development, the growth of industry associations spurred the state into financially supporting large-scale investment in charging infrastructure. Enova, a public agency set up to support clean transport projects, funded a nation-wide build-out of BEV charging infrastructure, with a non-statutory target of installing at least one charging station every 50 km by the end of 2017.

Despite exponential growth over the past few years, it is important to differentiate the number of EVs in Norway as a percentage of new car sales (~35%) versus the number of EVs as a percentage of the total car fleet (~2.8%). Even with long-running and generous incentives, a significant conversion from petrol/diesel to electric vehicles remains a much longer-term prospect.

Targets

In 2012, the Norwegian government published the Climate Policy Settlement, which contained a non-statutory strategic ambition for the country to be carbon-neutral by 2050 (Norwegian Climate Settlement). The government's Nationally Determined Contribution to COP21 also pledged to reduce GHG emissions by 40% in 2030, relative to 1990 levels – in line with EU policies. Although the government has not published a concrete quantitative goal with respect to EVs, a wider, non-binding target was set for new passenger vehicles to emit on average no more than 85g CO_2/km by 2020 (which are, in fact, 10% more stringent than EU-wide targets). Levels in 2014 stood at around 110g CO_2/km, down from 183g CO_2/km in 2001 (Norwegian Government – 'Environmentally-friendly transport').

The Norwegian government is currently consulting on its fifth National Transport Plan (NTP) covering the period 2018-2029 (Norwegian Government, National Transport Plan). This document contains a goal for all new private cars, city buses and light vans to be zero-emission vehicles by 2025. It has also put forward a target to halve transport emissions by 2030 relative to a 1990 baseline.

Analysis has found a high degree of support and acceptance of electromobility from both the political establishment and the general public and industry (Nils Fearnley, Paul Pfaffenbichler, Erik Figenbaum, Reinhard Jellinek). Norway's broader emissions targets were met with cross-party political consensus as early as 2008 (Norwegian Government, Cross-Party Statement on the Climate Report). Parliament approved the government's draft Climate Policy Settlement with only minor points of disagreement – for example, the extent to which jurisdiction over incentives such as free parking and access to bus lanes should rest with local authorities (Norwegian Government, Parliament Response to Climate Settlement). Industry stakeholders have also been broadly supportive, with electric utilities such as Fortum receiving government-sponsored grants that have helped the company become the largest operator of charging infrastructure in Norway (Fortum, Operations in Norway, February 2016). The state utility Statkraft also recently acquired a controlling stake in Grønn Kontakt, the second largest charging operator.

Timescales

The government's target of having only zero-emission new vehicles by 2025 has been interpreted in the popular press as an effective ban on sales of petrol and diesel vehicles from this date. Government spokespeople have denied this, stating that the intention is rather to make zero-carbon vehicles the most attractive option through 'carrots' rather than 'sticks'.

In the Climate Policy Settlement of 2012, it was stated that fiscal incentives for zero-emissions vehicles would be upheld until the end of the parliamentary session in December 2017, or until 50,000 such vehicles had been registered (Norwegian Government, Energy and Environment Committee Report, Recommendations to the Parliament). In fact, this milestone was reached much earlier, in April 2015. In response, the government decided in its Revised National Budget to extend the zero rate of VAT for electric vehicles until 2020, thus continuing a key driver of growth in electromobility (Norwegian Government, National Budget 2017).

However, it remains uncertain how much longer Norway's BEV incentives will last. The latest period of exponential growth has begun to weigh on public finances and transport infrastructure. The 2017 National Budget has calculated that the zero VAT rate for low-emission vehicles has reduced the average per-vehicle tax take by around NOK 15,000 (£1,400). This amounted to around NOK 2.75 billion (£260 million) of foregone tax receipts in 2016 (Norwegian Government, National Budget 2017). There is also a growing perception that incentives are benefitting wealthier parts of society, particularly as luxury models offered by manufacturers such as Tesla or BMW become ever more popular. Pressure has therefore been mounting to gradually raise tax receipts from BEV sales. In response, the Conservative government in 2016 put forward proposals to raise the annual motor tax

on electric vehicles from NOK 445 (£42) to NOK 1,200 (£115) (Norwegian News, 'Electric cars may lose incentives', 20.10.2016).

There are also concerns about BEV's preferential use of transport infrastructure. Municipalities are complaining of revenue shortfalls from 'free-riding' BEVs which do not pay for road or ferry tolls. In response, the National Transportation Plan 2018-2029 contains proposals to progressively reinstate charges on ferries and introduce a reduced, rather than complementary, rate on highway toll booths. There are also suggestions that EV access to bus lanes become conditional on local traffic developments.

It is not yet clear as to when these restrictions will be put in place. The government's coalition partner, the liberal/green Venstre party, is a steadfast supporter of BEVs. Stakeholders such as Enova, the Norwegian EV Association (NEVA) as well as an ever-expanding number of BEV owners constitute a powerful lobby against any 'premature' rollback in state support. NEVA argues that, despite recent growth rates, benefits should remain in place given that less than 3% of the overall car fleet in Norway is electric (Norwegian Electric Vehicle Association, 'The Norwegian EV success continues'). Nevertheless, as their numbers grow, electric vehicle incentives may find themselves at odds with the wider goal – also stated in the 2012 Climate Policy Settlement – that future growth in travel demand should be absorbed by public transport, bicycling or walking, rather than through private vehicle ownership. Indeed, there is a growing awareness that the penetration of EVs should not be viewed as an end in itself, but rather as one of many means to decarbonise the transport sector.

Communication

Norway was the first country in the world to implement a CO_2 tax on petroleum production, in 1991. Successive policy interventions to impose greater costs on the environmental 'externalities' of economic activity were framed as a means to neutralise the country's carbon footprint, which was particularly effective given the population's awareness of Norway's substantial exports of fossil fuels (European Perceptions of Climate Change project). Moreover, environmental policies were presented to the public as not inherently conflicting with economic growth, which ensured that they were met with broad approval (despite scepticism from energy-intensive industries) (Kasa 2011). When a progressive CO_2 tax component on vehicle purchases was introduced in 2007, it was justified by the government not only as a means to further reduce GHG emissions, but also as a trade-off in exchange for increased investment in public transport (Sælen & Kallbekken 2011).

To encourage public acceptance of BEVs, the government-funded agency Enova sponsored communication campaigns, such as a website called Grønn Bil (Green Car), which published statistics on electric vehicle registrations and information on charging points (Comparison of leading electric vehicle policy and deployment in Europe). This has recently been taken offline; incentives are now well known and an industry has grown around BEV sales offering such services. The main channels of public information diffusion are now bottom-up factors such as the 'neighbour effect' as well as municipal marketing campaigns, such as in Oslo which has been crowned 'EV capital of the world.'

Overall, Norway enjoys popular public support for electromobility. However, there are some analysts who have questioned whether these vehicles are as environmentally beneficial as presented by government (Holtsmark & Skonhoft 2015). They have pointed out that EV incentives encourage households to drive more frequently than they might otherwise, foregoing other means of transport such as cycling or walking. Taking into account lifecycle emissions, such studies argue that subsidising BEVs may not be the most effective path to decarbonising transport. In socioeconomic terms it has been noted that many BEVs in Norway are purchased as second cars, and that the incentives tend to benefit wealthier parts of society who, among other things, have the means to charge them from home. Despite these concerns, the ruling parties in government have

maintained their supportive position towards BEVs, continuing to argue that they contribute to the country's decarbonisation goals and reduce local air pollution.

Overall, a combination of progressivity and policy incrementalism in imposing tax burdens on fossil fuel use in transport, along with robust communication of incentives to adopt lower-emission vehicles, have ensured minimal levels of public resistance to electromobility (Norwegian Government, 'An assessment of excise duties'). Notwithstanding a natural resistance to higher taxes, the majority of Norwegians remain of the opinion that carbon taxes are an effective means of combating climate change (Rosentrater et al 2015).

Context-specific factors

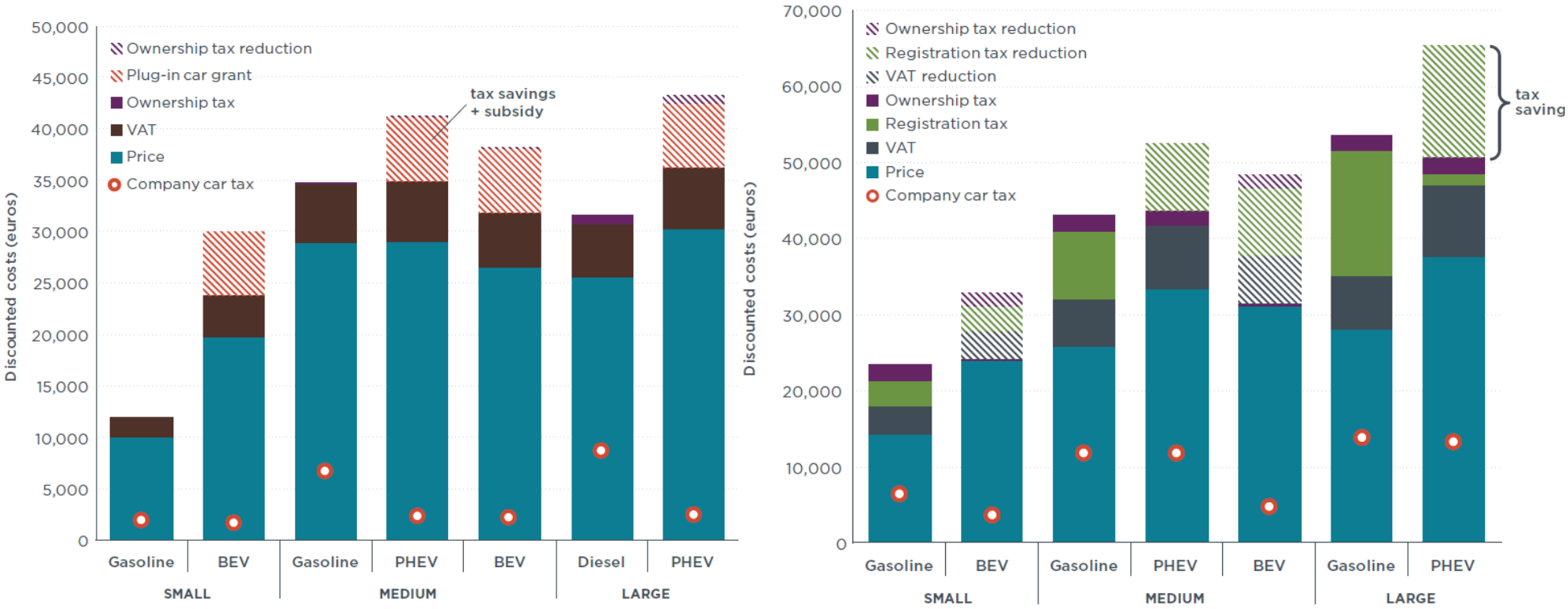
Norway has a sizeable budget surplus as well as the world's largest sovereign wealth fund, and can thus afford to forego tax receipts to support zero emission transport. 98 per cent of its electricity comes from renewables, meaning that the fuel source for BEV is carbon-free. Petrol prices are among the highest in Europe, whereas electricity is comparatively cheap.

However, despite fiscal leverage and generous incentives, technological and supply-side barriers in Norway prevented any significant level of BEV uptake, as the domestically-produced models of the late 1990s and early 2000s were unable to deliver a mass-market combination of availability, affordability, and quality. Significant growth in BEV sales began only after 2010, when advances in battery storage technology and a renewed global focus on decarbonising transport increased the supply of BEVs. A new generation of models designed by big auto manufacturers led to heightened competition and rapidly falling prices. With demand-side incentives already in place, BEVs were able to compete with higher-taxed internal combustion engine vehicles (ICEs), both in economic terms as well as for day-to-day convenience. The result was dramatic growth, with Norway quickly becoming the largest per-capita EV market in the world. Today, every third vehicle sold in Norway is electric.

The high growth in BEV penetration can also be explained by Norway's long-running policy commitments, which have made BEVs less of a novelty for citizens, thereby reducing perceived risk. As the technology matured and improved over time, the burdens of owning a BEV, such as high upfront costs, greater discomfort, less safety and a lack of charging infrastructure, were progressively removed. Early 'trial-and-error' experiences became a reference point for citizens who were now observing dramatic improvements in range and reliability, as well as availability and cost.

While the reasons for purchasing BEVs may differ among individual purchasers, the key incentives are ultimately practical/economic, rather than ethical/environmental. One of the most prominent analysts of electromobility in Norway has concluded that "in general, VAT exemption and access to bus lanes are the two most important incentives for BEV sales in Norway" (Figenbaum, Assum & Kolbenstvedt 2015). This implies that generous economic incentives can overcome other diffusion barriers – such as anxieties related to vehicle range, charger availability and overall convenience – at least in the early period of technological uptake. With this in mind, Figure 2 below shows that while the upfront costs of a BEV in the UK are competitive with conventional gasoline vehicles, the cost advantage in Norway is of an order of magnitude higher.

Figure 2: Direct Incentives for EVs in the UK (left) and Norway (right), (Tietge et al 2016).



Conclusions

- Norway has one of the most generous and long-running incentive structures for battery electric vehicles (BEVs) in the world. This has enabled dramatic growth in electromobility, particularly over the past few years as technological and supply-side barriers have been removed. Despite the recent surge in growth, less than 3% of the total car fleet is electric; the remainder is a roughly even split between petrol and diesel vehicles.
- EV incentives have evolved in a piecemeal fashion over a long period of time. The removal of VAT rates, registration fees and annual motor taxes has progressively encouraged uptake. Other incentives to purchase BEVs have been implemented, such as access to bus lanes, free parking and tolls, and reduced ferry charges. Norway's high taxes on conventional vehicle ownership has made low emissions alternatives more attractive.
- Concerns have been raised that the success of EV policies have raised the cost of state support and the burden on public transport infrastructure. Despite earlier policies that extended the zero rate of VAT for EVs from 2017 to 2020, the government's latest policies propose a gradual phasing out of other incentives, such as low registration taxes and ferry rates or unconditional access to bus lanes.

Appendix: Key indicators for electromobility in Scotland and Norway

	Scotland	**Norway**
Population	5.3m	5.2m
Area (km2)	79,000	385,000
Public roads (km)	59,000	93,000
Annual vehicle Km (millions)	44,800	44,250
Registered Vehicles (m)	2.9	2.6
of which Electric Vehicles	0.8%	2.6%
Standard Charging Points	600	2000
Rapid Charge Points	150	280
Direct consumer incentives	• Plug in Car Grant • Interest-free loan* • Lower ownership tax • Lower company car tax	• Reg. tax exempt • VAT tax exempt • Lower company car tax
Indirect incentives	• Go Ultra Low City Schemes • Free public charging • Municipal incentives (free parking/charging points)	• Free access to toll roads for BEVs • Reduced ferry rates for BEVs • Free parking in municipal parking lots • Free charging at public chargers • Access to bus lanes
Charging Infrastructure	• Electric Vehicle Homecharge Scheme: up to 75% of total cost • 40 million euros for 2015 to 2020 • funding for companies to install charging equipment*	• Funding for charging stations 2009-2010: ~12 million euros • Funding for fast chargers 2013: ~0.7 million euros • Ongoing funding for fast chargers

Nb. Incentives are UK wide unless denoted by an asterisk

Sources: ICCT 2016, Transport Scotland, Norwegian Statistics Office, ChargeMap Norway

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Case study 6: Agricultural nitrogen management policy in Denmark

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Policy description

Agriculture is an important contributor to greenhouse gas (GHG) emissions. In Europe it is responsible for 10% of total GHG emissions (Eurostat: Greenhouse gas emissions, EU-28, 2012). Notwithstanding recent efforts policies directly targeting agricultural GHG emissions in the European Union are slow to emerge (Frelih-Larsen et al 2014; Martinau et al 2016). particularly those targeting sectors outside of the Emission Trading Scheme (European Commission: 2030 climate & energy framework). However, as nitrogen pollution (mostly nitrate leaching and ammonia (NH_3) emissions has been targeted by policy since the 1970s across Europe to improve water and air quality, with synergistic effects on nitrous oxide (N_2O) emission reduction, the focus of this case study is nitrogen (N) management policies.

Denmark, as a major agricultural producer, has been suffering from significant marine, freshwater and groundwater pollution and air quality problems, still in 2013 applying 50% more nitrogen on their agricultural area on average and generating twice more nitrogen emissions than the UK (Eurostat 2016) (see Appendix 2). A series of policies have been introduced since 1985 to manage these problems, bringing a 40% reduction in the nitrogen surplus of the country by 2010 from its peak in the 1980s (Dalgaard et al 2014). Policies have been focusing on four broad farming management areas: crop fertilisation rates (including synthetic and organic nitrogen and phosphorous), livestock stocking density, manure storage and spreading technologies and buffer zones and artificial wetlands.

Although the Danish environmental legislation predates that of the EU, the policies are now closely related to the Nitrates Directive (European Commission: The Nitrates Directive) (the whole Danish agricultural area is designated as Nitrate Vulnerable Zones), the Water Framework Directive (European Commission: The EU Water Framework Directive) (WFD), the Habitat Directive (European Commission: The Habitats Directive) (HD) and the National Emission Ceilings Directive (European Environment Agency: National Emission Ceilings Directive). The current policy mix is a composite of regulation, market-based instruments and information provision (more details in Appendix 1).

Agricultural climate change policies can be expected to evolve in the near future in Denmark, to align the sector with the overall Danish Climate Policy Plan which aims to achieve a 40% reduction in GHG emissions by 2020 in comparison to 1990 levels (Danish Government 2013). The overall policy target, also informed by a bottom-up economic analysis of Danish mitigation measures (Danish Government 2013), is set to achieve mitigation in line with the long-term EU target of 80%-95% reduction by 2050. Though agriculture is considered in the Climate Policy Plan, there is no GHG mitigation target at the moment assigned to this sector.

Targets in the policy

Danish nitrogen policies have evolved in seven major stages since 1985 (Table 3, with further details in Appendix 1). Historically the policies were based on input targets (e.g. nitrogen application rate or stocking density), though some recent elements feature output targets (mostly related to ammonia emissions) and in the last two decades there have been some movement towards geographically targeted policies (Eurostat 2016). Policy targets are informed and supported by measurement and modelling based on a comprehensive soil sampling system, annual yield trials, farm and field scale statistics on nitrogen, groundwater and marine sampling system and ammonia monitoring stations.

Previous targets for reduction of nitrate leaching have been set at the national scale and the measures adopted had national scope. For example, farmers were obliged to maintain crop cover over winter on a percentage of their land, either by sowing winter crops or cover crops, and buffer zones up to 10 m width were required bordering all water courses and lakes larger than 100 m^2 (Danish Environmental Protection Agency: Groundwater and surface water). The new Agriculture and Environment Package (some details of which are still under development) will target measures according to i) site-specific estimates of the proportion of nitrate leaching from the root zone that reaches specified inshore waters, and ii) the target for nitrogen loading for that specified inshore water. This means that farmers will be faced with different demands, depending on the water catchment area in which their farm is located, the nitrate reduction target for that catchment, the soil type and extent to which denitrification removes nitrogen as it drains from the land and passes through the aquatic ecosystem to the inshore waters.

Table 3 Danish agricultural nitrogen policy timeline with main targets (Eurostat 2016, Danish Environmental Protection Agency: Overview of APAEs and the Green Growth Agreement, Kronvang, B., Andersen, H. E., Børgesen, C., Dalgaard, T., Larsen, S., Bøgestrand, J. and Blicher-Mathiasen, G.)

Policy	Main targets
NPo Action Plan (NPo) (from 1985)	Reduction in nitrogen- and phosphorous-pollution
The First Action Plan for the Aquatic Environment (AP-I) (from 1987)	Halve nitrogen-losses and reduce phosphorous-losses by 80%
Action Plan for a Sustainable Agriculture (AP-Sust) (from 1991)	Reduce nitrogen-losses from agricultural fields by 100 kt nitrogen
The Second Action Plan for the Aquatic Environment (AP-II) (1998-2003)	Reduce nitrate losses by 62%
Ammonia Action Plan (Ammonia AP) (from 2001)	Reduce ammonia emissions by 33%
The Third Action Plan for the Aquatic Environment (AP-III) (Danish Government 2004) (2005-2015)	Reduce nitrogen-leaching by further 13% and reduce excess phosphorous by 50% by 2015
Green Growth Action Plan (GG AP) (Danish Government (2009) (2010-2020)	Reduce nitrate losses by 1/3, reductions in ammonia and GHG emissions and pesticides losses, increasing biodiversity by increase organic food production
Agriculture and Environment Package (AEP) (from 2016)	Reduce nitrate leaching from about 57 to 42 kt nitrogen/y by 2021 whilst allowing farmers to apply more nitrogen than at present

Between the mid-1980s and early 2010s nitrogen use efficiency of Denmark has doubled (from 20% to 40%), nitrogen use dropped by 1/3, with similar decrease in nitrogen load to coastal waters. Ammonia emissions from agriculture and ammonia deposition got reduced by 30% and 20-25%, respectively, while N_2O emissions (though not targeted) decreased by 35%. The upward trend in groundwater and drinking water nitrate concentrations has been reversed, though the improvements in that respect are not as clear as for other effects (Eurostat 2016). Latest measurements show that nitrate leaching appears to have been increasing slightly over the past three years, even after correcting for variations in precipitation, although the increase is still within the margin of uncertainty of the measurements (Aarhus University 2016).

Timescale of implementation

The implementation of nitrogen policies now spans for three decades in Denmark, with seven Action Plans (APs) each spanning 3-10 years and partially building on each other. Usually the programmes followed one another and had midpoint evaluation, where additional action could have been taken if progress was insufficient. The programmes are normally negotiated across the political spectrum, with an attempt to get broad backing. That way, the programmes survive changes in governments.

The main target within the AEP is reducing the nitrate leaching to 42 kt nitrogen/y by 2021, as this has been agreed with the EU Commission in connection with the WFD. To achieve the required reduction in nitrate leaching despite the increased nitrogen quota, the government will subsidise a number of measures, primarily taking land out of agriculture (into forestry or restored wetlands) or applying end of the pipe solutions (e.g. mini wetland denitrification areas, mussel farming). These measures (still under development) would all be voluntary, although the government retained the right to impose measures if the uptake was insufficient to meet targets. However, the EU Commission intervened since it was not convinced that the measures envisaged would enable Denmark to comply with the WFD, and threatened to remove the derogation for cattle farmers (230 kg nitrogen/ha in manure, not the usual 170) and take the Danish government to the EU court. The Danish government finally made cover cropping compulsory (with financial compensation) in the most sensitive catchments.

Communication

The initial regulatory measures from the 1980s onward (mainly controlling stocking density and slurry spreading) were successful and effective because they were aligned with farmers' economic interests; the low utilisation of manure nutrients and the high synthetic nitrogen application rates were offering the potential for cheap and beneficial changes: "farmers associations from the very start supported the development, test and implementation of new low-emission technologies for manure management and for application". At that time the inter-farm variation in nitrogen efficiencies were very high, thus it's likely that the regulatory measures mostly affected the farms which had not embarked on the voluntary action route. (Nevertheless, opposition views from the farmers were also present, arguing that agriculture had no role in aquatic pollution.) Additionally to the regulations, the farms received tax subsidies for capital investments on the farm.

Over the years there was a constructive discussion between the governments and the industry concerning the best way for environmental objectives to be achieved. In general, the policy decisions considered the economic aspects of the measures, not only promoting the most cost-effective solutions but also investing in reducing the costs the farmers had to bear. The pressure to increase the utilisation of nitrogen in manure and reduce nitrogen losses has encouraged the development of practical measures such as trailing hose slurry application, phase feeding of livestock (where the protein content is adjusted over the lifetime of the animal) and acidification of slurry in housing or prior to application. The pressure to reduce nitrogen pollution has been increasing in all EU countries and because Denmark was one of the pioneers in this area their support industries are now in a good position to sell their technologies into markets outside Denmark (Hutchings 2014).

The government – industry dialogue tended to break down in the period after 2000, due to increased costs of compliance. The government attempted to revive the dialogue by establishing a Nature and Agriculture Commission, which reported in 2013 (Nature and Agriculture Commission 2013). Although its recommendations were generally welcomed, increased pressure on farmers, including market and financial difficulties, led to the formation of a breakaway group from the Danish farmers' association. This breakaway group has an over-representation of farmers with larger farms, so the members of this group control about half the agricultural land in Denmark. This group is highly critical of all aspects of the environmental legislative system and has waged a high profile campaign in the media and through the justice system. Their activities have led the established Danish farmers' association to take a more critical stance on environmental issues.

The recent AEP was developed by the minority Liberal government, with the help of a number of other centre-right political parties. The Liberal party has its roots in the farming communities of Denmark and was keen to improve the economic situation for agriculture. At the time, agriculture was under pressure from the collapse in milk prices and the effects of the Russian embargo on the import of agricultural products from the EU. The breakaway farmers' association had close connections with the Food, Agriculture and Environment minister at the time, and made a significant input to policy formation. Aarhus University (AU) has an agreement with the government to provide independent scientific advice concerning agriculture and the environment, and was asked to assess the environmental consequences of the change in policy. The Ministry chose to present the results of this assessment in a way that AU could not support but AU was initially prevented by the confidentiality clause in its agreement from speaking publically about this matter. However, the Danish parliament initiated an investigation and the Minister was obliged to resign.

The AEP was publicised via the usual news media and the details were communicated to the farmers' organisations. In these latest policy developments the move towards more targeted regulation was generally welcomed but the increases in permissible plant available nitrogen application and the decision to transfer the cost of pollution abatement measures from the agricultural industry to the taxpayer were and are contentious.

The public is mostly supportive of moving towards sustainable agriculture: the most recent Eurobarometer survey found that Danes consider the two main priorities of farming to be protecting the environment and ensuring the welfare of animals. 61% of Danes (compared to 43% of EU-28) think that the EU should ensure a sustainable way to produce food (European Commission 2016).

Context-specific factors

The initial regulatory policies were largely supported by the farmers as they were aligned with their economic incentives and were actually reinforcing a trend in voluntary action. Recently the increasingly stringent nitrogen regulations highlighted the trade-offs between nitrogen efficiency improvement and farm profitability. The balance was disturbed by increased financial and eventual political pressures for a relaxation of the quota. The relaxation of input control and introduction of end-of-pipe solutions might also result in trading off other environmental gains (notably N_2O mitigation and groundwater quality) with the new AP.

The policies since 1985 have worked for a number of reasons. The Danish governments have been working on building a consensus, both across the political spectrum and with stakeholders. On the technical side, the key factors in nitrogen pollution (livestock numbers and fertiliser use) are monitored on a farm-by-farm basis via nitrogen planning and obligatory farm-scale reports from slaughterhouses and fertiliser suppliers.

Unlike the damage caused by GHG emissions, most nitrogen pollution is highly location specific; extensive modelling and measurement capacities have enabled the consideration of this factor in the policies leading to the current development of some site specific regulations.

The different type of policies can have synergistic effects on each other. For example, the strict nitrogen quota have driven the uptake and further development of manure storage and fertiliser spreading technologies and had increased the market value of manure beyond the increasingly strict obligatory minimum rates of fertiliser substitution rates of manure (Eurostat 2016). (Fertiliser substitution rate indicates how much synthetic nitrogen the manure nitrogen is worth (it is less than 100%)). Similarly, the stocking density and minimum land requirements prevented very high livestock concentrations, avoiding the situation occurring in the Netherlands where manure transport and market need to be strictly monitored to ensure compliance with manure spreading regulations (Eurostat 2016).

Though the climate of Denmark and Scotland are not very different, geographical constraints led to less intensive agricultural production in Scotland than in Denmark, where a higher proportion of

intensive livestock farms requires imported feed, housing and manure management (see Appendix 2). The higher intensity and the different soil structure brought about more severe nitrogen problems in Denmark, while the higher proportion of capital-intensive farming (i.e. dairy and pig production) reduced barriers in the uptake of technology intensive solutions. Overall, though policy and technological solutions used in Denmark might not be suitable to all areas and farm types in Scotland, they could be relevant particularly to more intensive agricultural areas.

Conclusions

- Water and air pollution concerns have been driving agricultural nitrogen (and phosphorous) policies in Denmark for 30 years, resulting in considerable improvements in nitrogen utilisation and synergistic effects on N_2O emissions
- Cross-party agreement and dialogue between the governments and the industry underpinned policy development for three decades, though the progress has been recently reversed due to a combination of agro-economic and political factors when external market and financial impacts gave profitability and viability increased importance, with environmental regulations (particularly the nitrogen quota) seen as a restriction
- Comprehensive data from multiple sources on livestock numbers and nitrogen use, along with wide ranging measurements of nitrogen compounds in the aquatic environment and air, provide quantitative basis for monitoring and policy development
- All nitrogen sources on farm have been targeted, including synthetic nitrogen, manure nitrogen and nitrogen in livestock feed; particularly the reducing nitrogen quotas creating a strong incentive for technological improvement in manure nitrogen utilisation
- Technological development in livestock housing and manure management achieved in Denmark ahead of most other European countries allowed the supporting industries to become provider of these solutions internationally
- Regulatory approaches worked well while efficiency savings and technology improvements could support farmers complying at a low cost (or actually generating savings)

Appendix 1: Details of the Danish policy

The main elements of the policy regarding nitrogen are the following:

- Obligatory nitrogen management planning and nitrogen application records on farms
- Field level obligatory quotas for nitrogen application (depending on soil, climate, previous and actual crop choices, and location considering marine pollution potential)
- Obligatory catch crops in areas sensitive to groundwater contamination
- Financially subsidised, voluntary uptake of nitrogen leaching reducing measures (e.g. artificial wetlands); the suite of measures is location specific
- Slurry storage and spreading regulations (obligatory slurry store covers, obligatory use of slurry injection or immediate incorporation on bare soils, use of low-emission technologies on grassland and cropped land)
- Stocking density regulations; the farmer must own or rent sufficient land to efficiently utilise the manure from their livestock (exporting manure is permitted, provided they have a written agreement with the recipient farm)
- Information provision on low nitrogen excretion livestock feeding, coupled with allowance for increased stocking rates if the farmer can prove that the nitrogen content of the feed is below the standard value for their livestock
- Wetland rehabilitation and afforestation

The history of the most important nitrogen related elements of the Action Plans is detailed in Table 4.

Table 4 Some details of the Danish agricultural nitrogen policy packages elements (Eurostat 2016, Danish Environmental Protection Agency: Groundwater and surface water, Danish Environmental Protection Agency: Overview of APAEs and the Green Growth Agreement)

Policy	Elements
NPo Action Plan	· Max. 2 livestock unit/ha stocking density · Autumn ban on slurry spreading · Manure storage measures
The First Action Plan for the Aquatic Environment	· Minimum 9 months slurry storage capacity · Mandatory fertiliser and crop rotation plans · Minimum winter crop cover
Action Plan for a Sustainable Agriculture	· Nitrogen quota introduced (at economic optimum, The economic optimum N application rate for a crop depends on the variety (higher yielding varieties normally requiring more N) and on the relative price of N and grain) · Extended ban on slurry spreading · Statutory norms on plant-available nitrogen in manure
The Second Action Plan for the Aquatic Environment	· Nitrogen quota 10% below economic optimum · Max. 1.7 livestock unit/ha stocking density · Subsidies to artificial wetlands and afforestation · Minimum catch crop planting

Policy	Elements
Ammonia Action Plan	· Animal housing and manure storage subsidies · Ban on broadcast spreading of slurry · Increased minimum catch crop planting
The Third Action Plan for the Aquatic Environment	· Closely related to WFD and HD · Further increase in minimum catch crop planting · Stricter statutory norms on plant-available nitrogen in manure · Tax on mineral phosphorous in livestock feed · Further wetland areas and afforestation
Green Growth Action Plan	· Nitrogen quota 15% below economic optimum · Promotion of optimised feed practice · Further buffer zones
Agriculture and Environment Package	· Nitrogen quota at economic optimum · Subsidies for end-of-pipe nitrate leaching solutions

Appendix 2: Brief comparison of Danish and Scottish agriculture

The similarities between Scotland and Denmark are the climate (mild, damp) and population (5.4 and 5.6 m for Scotland and Denmark respectively). Scotland has a bigger land area (7.8 *vs* 4.3 m ha in Denmark) and a higher share of cultivated land (71% and 61%, respectively). In Denmark dairy cattle and pig are the dominant livestock (dairy cattle Scotland: 176 000, DK: 582 000; pigs Scotland: 318 000, DK: 12 m) while in Scotland beef cattle and sheep stocks are higher (sheep Scotland: 6.7 m, DK: 151 000; beef cows Scotland: 437 000, DK: 97 000) due to the larger proportion of rough grazing in Scotland (50% and 1.4% of agricultural area in Scotland and Denmark, respectively). Average holding sizes are slightly smaller in Denmark than in Scotland (67 ha *vs* 106 ha), the employment in the sector is 2.5% in both countries, and contribution to exports is 17% in Denmark and Scotland too (including whisky exports). Agriculture contributes to 1.6% of gross value added in Denmark and 0.6% in Scotland (European Commission: Denmark – CAP in your country, Danish Agriculture and Food Council 2014, Scottish Government: Agricultural land use in Scotland, Scottish Government: Agriculture Facts and Figures 2016, Scottish Government: Export Statistics 2015).

The severity of nitrogen related problems are different in the two countries. A comparison of the United Kingdom, Denmark and EU-15 average shows that Denmark has a substantially higher nitrogen input rate, gross nitrogen balance and nitrogen emission rate than the UK and the EU-15 average (Figure 1, Figure 2, Figure 3). Nevertheless, reductions in these rates have been higher in Denmark than in the UK and the EU-15.

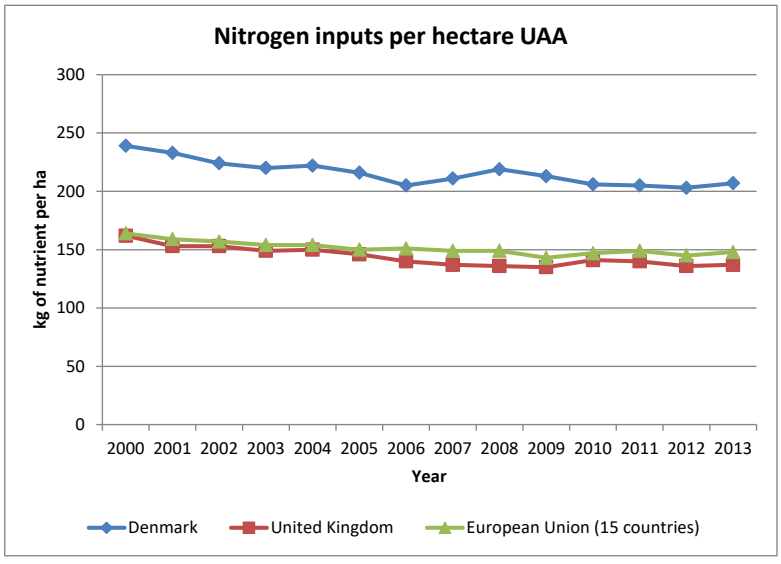

Figure 1 Nitrogen inputs per hectare in Denmark, United Kingdom and EU-1

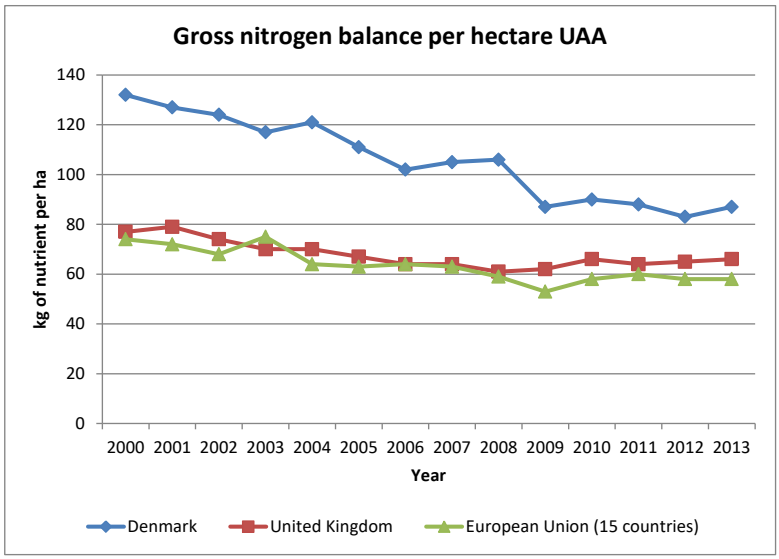

Figure 2 Gross nitrogen balance per hectare in Denmark, United Kingdom and EU-15

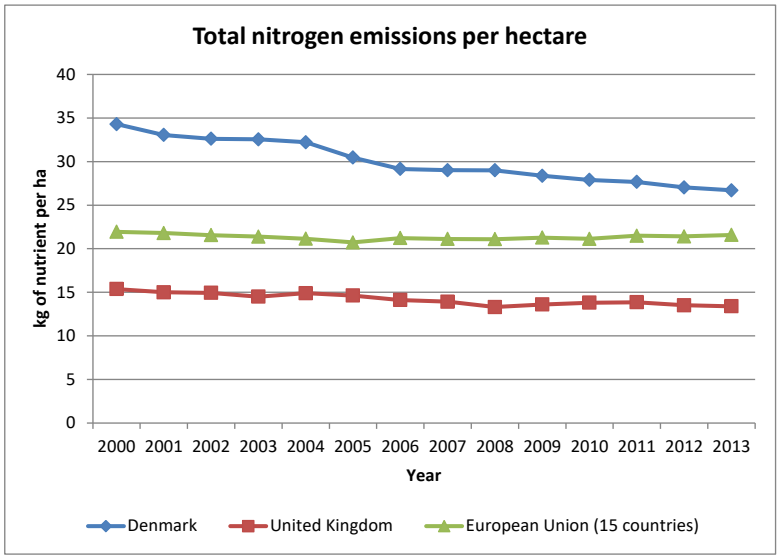

Figure 3 Total nitrogen emissions per hectare in Denmark, United Kingdom and EU-15

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Case study 7: Greenhouse Gas Emissions Reductions in France: The Agriculture Sector

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Summary

This report evaluates the current and recent historical policy environment of France with respect to greenhouse gas emissions reductions in the Agriculture sector. Its purpose is to provide policy-makers with relevant information on elements of the French experience that could be considered for incorporation into Scottish policy and strategic planning, as well as elements that may best be avoided.

Introduction

Agriculture in France accounted for roughly 17% of the country's domestic greenhouse gas (GHG) emissions in 2014 - or about 20% if emissions from energy use on farms are included. (This "extra" amount is officially accounted for in other sectors, such as Transport and Industrial Processes.) Different to other economic sectors, GHG emissions from agriculture are about 80%) non-carbon dioxide (CO_2) in origin, namely methane (CH_4) and nitrous oxide (N_2O). The sector accounts for roughly 80% of all such non-CO_2 emissions in the national inventory.

Much of France's GHG emissions reduction effort has been focused on CO_2, specifically in the 5-year journey to enact the Energy Transition Law (adopted in 2015). Due to the nature of the agriculture sector, where biological processes dominate technological ones, it is relatively more difficult to reduce CH_4 and N_20. Coupled with mitigation from land-use and land-use change (LULUC) accounted for in a separate 'sector' – despite mitigation activities potentially occurring on agricultural land – there are few "easy" wins. This is evident in the pattern of historical GHG emissions from French agriculture, as shown in the table below. Lagging behind other sectors in absolute GHG emissions reductions between 1990 and 2014, and being stagnant since 2005, agriculture's proportion of France's national GHG inventory has grown from 15% to 17%.

Given these fundamental differences between agriculture and other sectors, France's focus on absolute emissions reductions rather than proportion of total is appropriate. However, as opportunities for reductions in CO2 emissions wane or are exhausted, France will need to tackle the much harder decisions of how to reduce emissions of CH4 and N2O, both substantially more powerful GHGs that CO2. Whilst out of scope of this case study, altering the types of products demanded by consumers (through behavioural, attitudinal and/or cultural change) is potentially the single most significant lever that ultimately alters the emissions profile of the agriculture sector.

GHG Emissions (Mt CO_2e)	Total Agriculture Emissions	Enteric Fermentation	Manure Management	Soils
1990	83.2 (15.2%)	36.6	7.9	36.7
2005	78.5 (14.1%)	33.7	8.0	34.8
2009	79.1 (15.6%)	34.3	8.1	34.7
2014	78.9 (17.2%)	33.7	8.3	34.7

Table 1: Total GHG emissions attributed to agriculture in France at time key points in time.

The percentage of economy-wide total emissions attributed to agriculture is in brackets. Enteric fermentation is CH4 produced as a by-product of digestion, primarily from ruminants such as beef and dairy cattle. Livestock effluent emissions from manure are primarily CH4, levels of which depend upon management practice. N2O emissions from soils are primarily leakage of nitrogen from mineral fertilisers. Data source: Eurostat.

Policy Description

French policy focus for agriculture to date has been on reducing high-carbon energy use, seen as a key element to secure the long-term competiveness and sustainability of the agriculture sector. However, to achieve the levels of GHG emissions reductions required from agriculture, energy efficiency is not sufficient. The vast majority of agricultural GHG emissions are CH_4 from livestock (enteric fermentation and manure), and N_2O from the use of mineral N fertilisers in soil. As other economic sectors reduce their CO_2 emissions, agricultural CH_4 and N_2O will form a greater proportion of total French GHG emissions. Other frameworks and goals for absolute emissions reductions in agriculture fall into one (or more) of four categories, all but the final one presented here have specific policies that directly or indirectly target emissions reductions. These are: reduced application of mineral nitrogen fertiliser; increased storage of carbon in soils and biomass; reducing CH_4 and decreasing fossil-fuel energy dependency through biogas production; and, reducing CH_4 emissions from livestock digestion via changes in diet. As a result, many of the emissions reductions in agriculture are an indirect consequence of the application of policies to become more energy efficient rather than a driver of operational change.

Targets & Timescales

France has economy-wide GHG emissions reductions targets. These are detailed in several documents and policies, including the nationally determined contributions (NDCs) – agreed at the EU level in time to present at the United Nations Framework Convention on Climate Change (UNFCCC) COP21 meeting in Paris in November 2015 – as well as those in the EU's 2020 Climate and Energy Package of 2009. Objectives of the UNFCCC's other "nested" treaties and agreements, such as the Kyoto Protocol and the Paris Agreement, are also incorporated into French national level legislation.

GHG emissions from energy use in agriculture are about 15% of the sector's total emissions, and the focus of the bio-gas initiative. However, this does not include those emissions from energy use accounted for by other sectors (such as transport and industry) that are expended due to agriculture-related activities (eg. physically moving farm produce along the supply chain, as well as

processing it). Agriculture as an economic sector has some GHG emissions-related targets, though there are a greater number of broad, "green growth" objectives. Targets and objectives take the form of a series of policies and programmes, which have been rolled out over time. The National Low-Carbon Strategy (SNBC) sets out an emissions reduction target of 12% by 2030 for agriculture.

Targets have multiple timescales. At the top level are those based upon EU targets: i.e. 2020, 2030 and 2050. Distinct from Scotland's annual targets, but more in line with the UK as a whole, France has mandated the implementation multi-year carbon budgets for the period leading up to 2030. These budgets cover the periods 2015-18, 2019-23, and 2024-2028.

In November 2015, France announced absolute emissions reductions targets for the first three carbon budgets, set by decree, ending in 2028. Only the first budget period has separate expectations for within-ETS and non-ETS sectors. Relative to 2013, the former has its budget reduced 7.5% (from 119 Mt to 110 Mt CO_2e), whilst the latter sees an 11% decline (from 373 Mt to 332 Mt CO_2e). This is equivalent to cut of 8.4% economy wide. The second budget period (2019-2023) targets a 9.7% reduction versus 2018, whilst the third period (2024-2028) anticipates lowering the cap a further 10.3% versus 2023. If these budgets were realised as enacted, France would reduce its GHG emissions by 27% by 2028. This is well short of the EU's 40% target set for 2030.

Despite accounting for nearly 20% of French GHG emissions, within the SCNB framework agriculture has the lowest GHG reduction targets of any sector; 12% by 2028 and 50% by 2050. By implication, other sectors will need to generate greater GHG emissions reductions to compensate for agriculture's lesser short- and medium-term contribution. This recognises the relative difficulty in reducing CH_4 and N_2O emissions. As these emissions largely arise due to biological processes rather than technological ones, there are fewer 'levers' that may be employed in agriculture as compared to the energy-related CO_2 emissions of the other sectors of the economy.

For context, emissions reduction targets in each of the other sectors are as follows: transport (29% by 2028 and 66% by 2050); buildings (54% by 2028 and 87% by 2050); industry (24% by 2028 and 75% by 2050); energy (keep below 2013 levels by 2028; and 96% reduction by 2050); and waste (33% by 2028; no stated target for 2050). This may reflect the challenges of reducing the non-CO_2 emissions that dominate in agriculture relative to the energy-related CO_2 emissions that dominate in the rest of the economy. The particular targets for agriculture are detailed below, including the basis for the target, progress to date, and an assessment of likelihood the target will be achieved within its allocated timeframe.

TARGET: Reduce agriculture emissions 12% by 2028 versus 1990 (SCNB)

Rationale: Agricultural GHG emissions represent just over 17% of France's total domestic emissions (in 2014 - latest available figures from Eurostat) and over 80% of CH_4 and N_2O emissions, gases that are 28 and 280-times more potent than CO_2 with respect to global warming potential.

Progress: Absolute emissions fell 5% between 1990 and 2005. However, despite a variety of targeted initiatives (discussed below) agricultural emissions have since been stagnant.

Assessment: The target **can** still be achieved within the timeframe set out – almost 12 years remain to reduce emissions by 9% from 2014 level. However, renewed efforts will be required to target non-CO_2 emissions, which predominate in this economic sector.

Progress on other, more specific, elements is described below that should help reduce the carbon-intensity of agricultural production (a relative measure of emissions per production unit). These may indirectly support achieving the 12% absolute emissions target.

TARGET: 1,000 biogas plants by 2020 (EMAA Plan)

Rationale: Agricultural waste can be used as a renewable feedstock in the form of biogas. This displaces a proportion of energy otherwise provided by fossil fuels and avoids the emissions from the

waste that would otherwise occur. It provides a partial avenue for farms to be less dependent upon fossil fuels. The left-over "digestate" may also be used (subject to regulatory approval) as a fertiliser and lower the amount of mineral N fertiliser applied.

Progress: By September 2015 there were over 400 active biogas plants in France. Nearly three-quarters of these plants have been commissioned since 2011. A total of 740 are expected to be online by 2020 – an investment estimated at €800m. Subsidising exemplar biodigesters (total of €13m in 2009 and 2010), and initiating feed-in-tariffs in 2011 provided a kick-start to the industry.

Assessment: Whilst there has been a great deal of activity in the biogas market since 2005 in France, is seems **unlikely** that the target of 1,000 plants will be met by 2020. However, the 2016 decision to make permanent the tax exemption on biogas plants (originally a seven year exemption to 2022) is a further signal by the French government of support for the industry. The structure of French agriculture, which has the largest number and proportion of large farms (those with a utilised agriculture area (UAA) of over 50 Ha) in Europe, provides additional conditions that are beneficial for biogas plants – logistics are easier with fewer suppliers.

TARGET: Increase organic area to 6% by 2012 and 20% by 2020. (Le Grenelle commitment); Double organic area from 2013 to 2017 (Organic Ambition Programme 2017)

Rationale: Organic farming practices are believed to produce less GHGs (there is not a consensus on this position within the scientific community – more in final paragraph). Use of cover crops and less mineral fertiliser reduces N_2O emissions from soils, and N leakage into water (indirect benefit of it then requiring less treatment). The lack of use of man-made herbicides and pesticides, alternative tilling practices, and the inclusion of elements of agroforestry may also lead to improved biodiversity and soil organic carbon levels.

Progress: Over 400,000 Ha of fully converted organic area has been added since 2009, to an estimated 1 million Ha in 2015 – a near doubling in six years. This is equivalent to 4.8% of the utilised agriculture area (UAA) in France under organic practice in 2015, versus 2.9% in 2010 (and 1.9% in 2009). Unofficial estimates for 2016 by the organic industry body AgenceBio are 1.5 million hectares of farmland under organic production; 300k shy of the "double" target.

Assessment: The *Grenelle* target for 2012 was **missed**, which by 2016 still had not been achieved. There are risks and considerable knowledge transfer required to transition from traditional to organic practices, as well as time to do so. It seems **virtually certain** that France will also **miss** the 2020 target of 20%. With financial support to develop production (€160m per year for the period 2014-2020), demand-pull support (discussed below), and the acreage currently under conversion, it seems **virtually certain** the Organic Ambition Programme 2017 interim target of doubling organic acreage by 2017 versus 2013 will be achieved.

The French position that organic farming is less GHG-intensive than conventional farming is contested (see the following extensive discussion via the Food Climate Research Network). However, it is this position which drives the French targets of increasing organic production and consumption; they may not deliver the GHG emissions benefits sought. Additional detail on this topic is provided in Context-specific Factors section.

TARGET: 20% Organic produce used by institutions by 2020 (Organic Ambition Programme 2017)

Rationale: Create a demand-pull environment to encourage local production of organic produce. In turn, sustained market demand for this type of produce will act as an enabler for the target for organic farming.

Progress: Growth in the number of catering establishments with organic produce options has been rapid, from 4% in 2006 to 58% in 2016. Within this, 71% of public catering outlets offered organic options (led by schools where three-quarters serve organic produce) versus 41% of private outlets.

At the same time, the share of organic produce purchased at these establishments rose from 5% in 2008 to 14% in 2015.

Assessment: Growth in production, availability, and consumption of organic produce is clear and has been rapid. Availability has increased almost 15-fold in 10 years and market share in institutions has almost tripled in the past seven years. These trends suggest it is **very likely** that the 20% organic market share target will be met on time, **possibly** early.

TARGET: Doubling of area under legumes by 2020 (Land Objectives Plan)

Rationale: Legumes (pulses) are able to "fix" atmospheric nitrogen, thus providing a natural fertiliser and reducing the need for mineral N to be added to fields to increase/maintain crop yields.

Progress: Whilst the acreage given over to the production of leguminous plants within the EU-28 has been relatively stable since the 1980s (though with greater variability since the mid-2000s), France has experienced a decline. From a high of 750,000 hectares in 1993, acreage fell to a low of 197,000 ha by 2012. However, Eurostat figures for 2015 show an increase back up to 269,000 ha.

Assessment: France is not as competitive with respect to legume production versus other countries within the EU (particularly those in Eastern Europe), or further afield. French agricultural production has shifted from legumes to other produce where it does retain a competitive advantage. Whilst it is **possible** for meet the target of 430,000 hectares under legume planting by 2020, which would be a return to levels last seen in 2005, there is a good deal of uncertainty of whether it would be sustainable over the longer term.

Communication

France's first National Climate Plan in 2000 (then called the National Programme for Tackling Climate Change) required review every two years; the latest being in time for COP 21 in Paris. Local authorities are encouraged to adopt and adapt the plan with respect to local conditions.

Overall, climate policies appear to have had been subject to broad-based consultation, not only from experts and public bodies, but also NGOs, citizenry and other non-state stakeholders. The result appears to have been high levels of buy-in across the spectrum – though not always quickly. A prime example is the Energy Transition Law. This comprehensive legislative package is intended to transform France's economy with respect to energy use and boost "green growth". Enacted in August of 2015, it required four years of negotiation and consultation, and over a thousand amendments, to wind its way through the French National Assembly and Senate.

As the host of COP21, and the headline Paris agreement, effective communication strategies across a range of key stakeholders has been a key focus for France. This has not only been essential for national communication, but also extends internationally. In the agricultural sector specifically, potentially its largest campaign to date has been the "4 per 1000" initiative. The 4‰ Initiative was launched by France under the Lima-Paris Action Agenda (LPAA) at COP21 to demonstrate the important link between carbon sequestration and food security. Since this action is based on voluntary commitments between both private and public entities, effective consultation and engagement across a range of stakeholders (including national governments, local and regional government, companies, trade organisations, research institutes, and NGOs) has been essential. A vital strategy in gaining stakeholder support has been in the promotion of the co-benefits of carbon sequestration techniques (such as agroforestry, conservation agriculture and agroecology) in simultaneously realising food security and agricultural resilience benefits.

In terms of promoting action towards meeting its national agricultural mitigation targets, a key strategy in synthesised policy documents has been clearly outlining the range of mitigation options with analysis and discussion on their relative economic costs and benefits (in the form of mitigation abatement potential curves). These assessments draw on a range of published case studies which

review each of the mitigation techniques in detail. France disseminates information about the importance of mitigation and adaptation, and provides a toolkit for farmers to improve performance—these tools and educational resources are deemed to be accessible, user-friendly, and correctly oriented toward key stakeholders.

At present, it's difficult to assess how effective its recent communicative strategies (since COP21) are in driving change, France's approach to agricultural climate policy has been generally well-received. It has been utilised by the OECD as a case-study for the management of synergies and trade-offs in shaping policy action. This review highlights that the Ministry of Agriculture, Agri-Food and Forestry (MAAF) have been effective in *introducing new policies* which promote synergies between economic productivity and climate mitigation. The approach typically relies on compensating farmers (in the form of subsidisation, as evidenced in its biogas programme) for any eventual financial losses which may occur from uptake of mitigation strategies, and highlighting approaches which would reap economic gains at the farm-level.

Whilst the OECD commends France on success in promoting productivity-climate synergies, it suggests its policy framework could be improved through the design of incentives which *discourage* behaviours which undermine these efforts. This could come in the form of reductions in subsidies or payments which fail to promote policy synergies.

Context-specific Factors

In the reduction of non-CO_2 emissions (CH_4 and N_2O), France's approach and targets have been largely focused towards biogas and organic farming promotion to date. These options are considered to hold large mitigation abatement potentials in French agriculture, both at either low or negative costs. Beyond this rationale, there are several contextual factors which may explain this choice of focus. France's agricultural sector is the largest in the EU, and is among the largest exporting nations in the world (with an estimated value of 86 billion USD). At 30 million hectares, its agricultural land is the largest in Europe, accounting for nearly half of its total country area. Its agricultural strategies for CH_4 and N_2O mitigation will therefore be focused towards achieving emissions reduction without a loss of economic output. This is of particular importance for meat and dairy production, which form its highest value outputs (yet also are the most GHG intensive agricultural products).

In this context, biogas production forms an economically-sensible choice, offering a strategy for CH_4 mitigation without a loss of agricultural, and economic, output. Forming its largest agricultural output, the scale of its cattle industry provides a large and continuous input for biogas, in the form of manure and slurry. This strategy is also cross-boundary, proving effective in not only reducing GHG emissions from agricultural waste, but also supporting France's renewable energy targets. This synergy between the two sectors is seen as integral to the country's overall carbon strategy.

France may have some climatic advantage over Scottish agriculture for its choice of organic farming strategies. The adoption of organic methods, while typically reducing N_2O emissions per unit area (although not always per unit output), can result in yield losses across many crop species. Only a small range of crops—namely fruits and oilseeds—have been shown to almost match yields of conventional practices. France's climatic conditions are well-suited for the production of a wide range of agricultural commodities; oilseeds forms a major agricultural export, and its climatic conditions are also well-suited to fruit produce (acting as a supply for its 9.3 billion USD wine and spirit industry). As a result, France may be able to target increases in organic area towards specific crop types without significant output and economic implications. This approach may be less suitable in Scottish context, where crop outputs are dominated by cereals (which are much more reliant on nitrogen supply).

Beyond these strategies, agriculture has an advantage that most other economic sectors do not. Even without technologies that are yet to be proven at scale (such as bioenergy with carbon capture

and storage (BECCS)), it may be possible for the sector to act as a carbon sink through changes in practice. Increases in application of agroforestry techniques and organic principles have the potential to store carbon. The concept of carbon-farming, paying farmers for increasing the store (or reducing losses) of carbon held in the vegetation and soils on their land may be a further avenue to explore.

Conclusions

- Between 1990 and 2014, GHG emissions from agriculture in France decreased 5% from soils (mostly as a result of better mineral nitrogen fertiliser management) and 8% from livestock (primarily methane produced from digestion by beef and dairy cattle).
- France's policy framework is **complex**, with a multiplicity of goals, objectives, and targets.
- **Stakeholder** consultations have been influential to generate broad-based buy-in to the need for action related to GHG emissions, climate change and transitioning away from fossil-fuel based sources of energy.
- Despite a multitude of policies, objectives and targets, GHG emissions from agriculture in France are **little changed** since 2005, with the vast majority of reductions achieved **prior to 2009,** the implementation of the first Grenelle law.
- It is **unlikely** that French agriculture will meet its high level target of a 12% reduction in GHG emissions by 2020 relative to 1990.
- Achieving longer-term targets within agriculture will require tackling **methane and nitrous oxide** emissions. CO_2 emissions are a small proportion for this sector, thus providing less potential to make a meaningful impact.
- Targets **likely** to be achieved are those related to market share of organic produce sold by institutions. The intent is to provide a demand-pull incentive for increased acreage converted to organic methods.