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Arslangulov, Ural and Ackrill, Robert (2023) Agency, agents and their interrelations in multiple windows of opportunity, multiple streams and industry trajectories: creating a market for zero-emissions vehicles in the UK. In: International Public Policy Association, 6th International Conference on Public Policy, 27-29 Jun 2023, Toronto Metropolitan University, Toronto.

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Agency, Agents and Their Interrelations in Multiple Windows of Opportunity, Multiple Streams and Industry Trajectories: Creating a Market for Zero-emission Vehicles in the United Kingdom

Paper presented to Panel T01P03: Advancing the Comparative Study of The Multiple Streams Framework at the 6th International Conference on Public Policy (ICPP6), Toronto, 27-29 June 2023.

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Extended Abstract

In this paper, we present an initial analysis of work that seeks to understand, through a novel combination of concepts, the processes that are driving the United Kingdom's decarbonisation strategy for the automotive sector. As part of this work, we undertook extensive fieldwork interviews and documentary analyses that allowed us to explore the interlinkages in a context where policymakers seek to create a significant and sustainable new market (i.e., cars with zero tailpipe emissions) via policy incentives and where the basic technology exists (e.g., batteries), but where investment in technological development must come from the private sector, especially from several related industries within the automotive ecosystem. Moreover, these private sector actors have considerable self-interest in the shape of those policy incentives. For this work, we draw on the multiple streams framework (MSF), the multi-level perspective (MLP) and multi-level governance (MLG) to understand how technology, market and policy factors have jointly worked to put the British automotive industry on a specific trajectory. By adopting a pragmatist grounded theory approach, we find that this trajectory has come about through the interplay between technology innovators, problem brokers, bricoleurs, and policy

entrepreneurs (PE) performing activities in different types of windows of opportunity – technology, problem, policy and market – to achieve the ultimate goal of a functioning market for electric vehicles. This paper aims to answer three interrelated research questions. What is the relationship between technological, policy, problem and market windows of opportunity and multiple industry trajectories and multiple streams? Who are the key agents at play inside each window? What does this mean for the relevant actors and their interrelations within a particular window?

To visualise the complex interactions of the different agents and their activities in multiple windows of opportunity, an interactive 3D model was developed named Multi-level Governance and Strategy (MLGS) model (Figure 1). By analysing interview data, archival data and secondary materials, the answers to the three research questions can now be provided as follows.

RQ1: What is the relationship between technological, policy and market windows of opportunity with industry trajectories and multiple streams?

Technological windows (green areas in Figure 1) open in a related industry and are associated with a shift of the niche technology to the incumbent level in energy storage and energy supply industry trajectories supporting the shift of EVs. First, the battery industry trajectory with the automotive industry trajectory was coupled within the first technological window of opportunity (tWoO-1) allowing to the production of the first mass-market EV – Nissan Leaf. The second technological window of opportunity (tWoO-2) coupled energy supply, energy storage and automotive industries when the EV energy supply shifted from coil to renewable energy, the EV infrastructure network started to build up in the UK and battery technologies used in the cars continue to improve energy density, reliability and cost efficiency. After that, the national level environmental questions became answerable by using EV technology.

There was a series of policy windows of opportunity. The first policy window of opportunity (pWoO-1) on the national level opened between July 2016 – July 2018 while the Transport Energy Model (TEM) was developed and the work on Road to Zero took place (Figure 2). Work on the TEM was important as it informed the government on the environmental impact of various types of vehicle technologies and fuels. This resulted in the release of the Road to Zero strategy when the government shift away from being technologically neutral and focused on EVs. This strategic policy set targets for ULEV uptake up to 2030.

Automotive industry trajectory

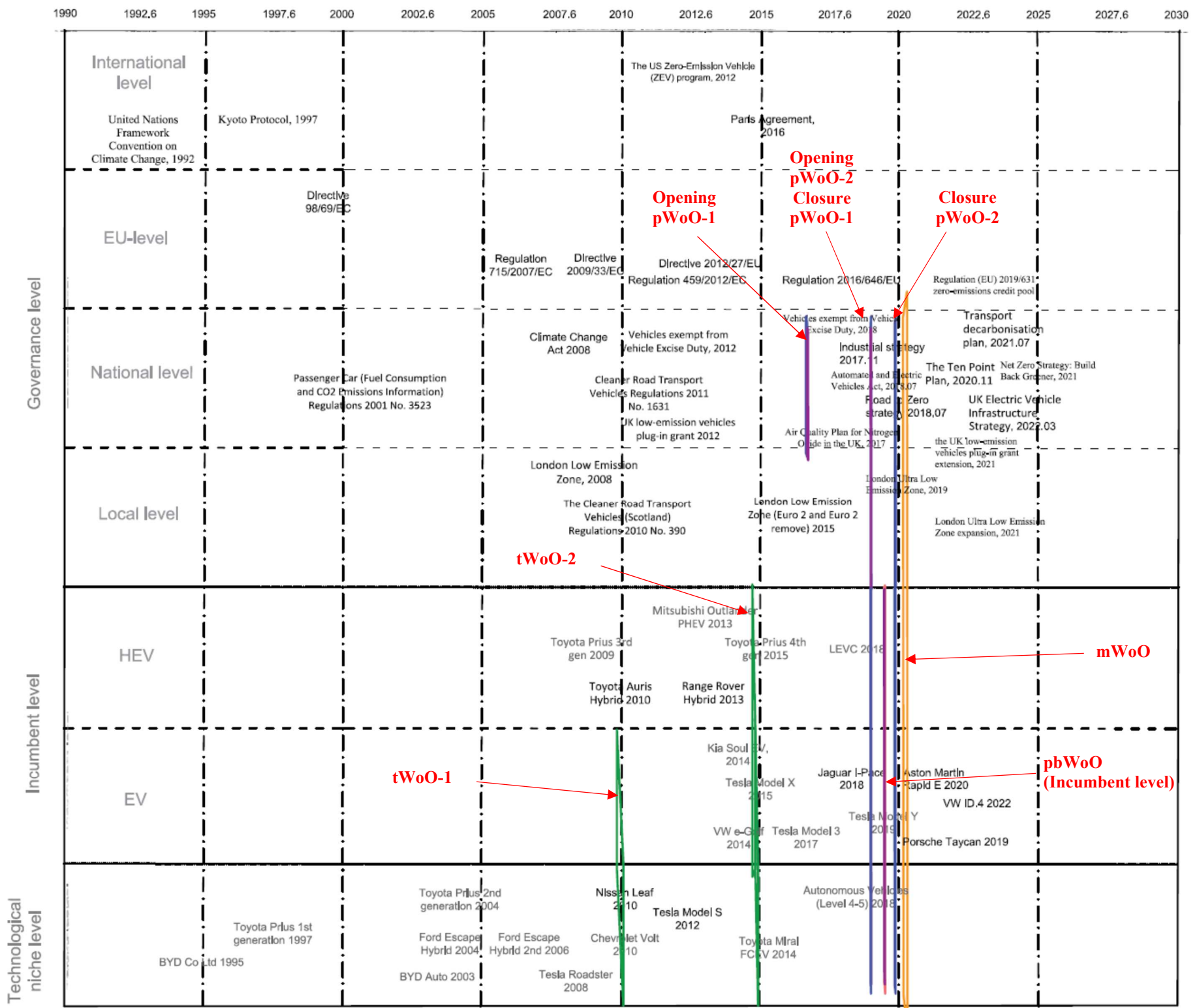


Figure 2 Automotive industry trajectory, top view

The second policy window of opportunity (pWoO-2) was opened at the national and technological niche levels of the problem stream and linked with the energy supply and infrastructure problem of the mass market uptake of EVs, which was interdependent with widespread adoption of this niche technology. The government set a Taskforce within the policy stream to accelerate the EV transitions and provide policy solutions for the incumbent level problems that incumbent actors may experience during the EV transitions in the UK. The pWoO-2 remained open for the period of 21 months while the work on Taskforce packages continued from June 2018 until March 2020.

After the closure of pWoO-2 the market window of opportunity was opened in March 2020 indicating diversification of EV models registered, and a significant increase in EV registration of 184%, accounting for 6.59% of total cars registered in the UK (Department for Transport, 2022). This indicated the shift of EVs to the incumbent level and the beginning of its mass market uptake.

RQ2: Who are the key agents that are in play inside each WoO?

In the case of the transformation of the automotive industry in the UK between 2017-2022 the following agents were identified:

- Policymakers: individuals or groups of individuals involved in formulating, developing or amending policy, for example, Head of the Government High-Profile Group, Ministers of Government;
- Policy Entrepreneurs: individuals who work within pWoO at the national, incumbent and market niche levels of policy stream by coupling policy, politics and problem streams. In the case under investigation, PEs were associated with directors of LowCVP who contributed to Transport Energy Model and Road to Zero policy plan, as well as provided secretariat functions for the Electric Vehicle Energy Taskforce (EVET). PEs have a purposive and reputational interest in the acceptance of policy proposals;
- External Bricoleurs at incumbent level of the policy stream. They operate within pWoO recombining policy solutions and coupling policy and problem streams. They can also couple incumbent level of the politics while reaching an agreement on EVET work package (WP) policy proposals. Bricoleurs were associated with WP leaders – research and trader organisations having expertise in WP topic;

- Problem Brokers (PB) focused on framing conditions as problems within the problem stream and coupling technological niche or incumbent level industry specific problems with social problems on the national level. Their activities can facilitate the opening problem WoO. PBs are associated with academics, senior managers of consulting organisations, or senior managers of companies from the energy supply, energy storage or automotive industries;
- Technology Innovators (TI) operate within technological WoO in technological trajectories. They can be carmakers' officials who develop technological solutions. In addition, they can take the role of PB.

RQ3: What do windows of opportunity mean for the relevant actors and their interrelations within a particular window?

Within the technological WoO, technological innovators were able to release an innovative product that is complementary to innovations in related industries. In the case under investigation, technological innovators released the first mass-market EVs in 2010 and enhanced the range of EVs in 2016 when tWoO-2 was opened. In addition, during the tWoO-2 TIs intensified the expansion of EV infrastructure. TIs in the energy supply industry continued diversification of EV energy supply, while TIs in energy storage trajectory improved energy efficiency and cost efficiency of Li-ion batteries. All these activities made EVs a viable technological solution to the air quality problem. Policymakers established Taskforce within the policy stream in response to the technological niche-level problem of the problem stream – lack of widespread adoption of EVs. Following this event, the director of LowCVP (secretary of Taskforce) can be seen as a PE who opened policy WoO within the policy stream by initiating work packages. The Taskforce provide opportunities for problem brokers to frame problems at incumbent and technological niche level of the problem stream. Then this problem was discussed at the WP meeting, where the problem solution was suggested and included in the draft of the WP by bricoleurs. After that, the WP draft was reviewed by PE. The policy solutions could be left as they were or modified by PE, and after modification, presented to the government. The final decision on the inclusion of policy proposals in the final policy was made by ministers of the government department.

After the initiation of work pages in June 2018, the market window of opportunity (mWoO) partly opened in September 2019. This is evident from the increase in registration of EVs by 141% compared to the previous year (Department for Transport, 2022). However, the number of EVs registered in proportion to the total number of vehicles in the UK was relatively small, accounting for 1.64%. The market window of opportunity fully opened in the next year after

the closure of pWoO-2 in March 2020. During this time the model range of EVs was significantly diversified wherein the market continues to grow by 184% accounting for 6.59% of total registered cars in the UK (Department for Transport, 2022). This signified the shift of EVs to the incumbent level and the beginning of mass market uptake of EVs.

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The 6th International Conference on Public Policy in Toronto

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Panel T01P03: Advancing the Comparative Study of
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Agency, Agents and Their Interrelations in
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Policymakers and Policy Papers Driving the Transformation of the UK's Automotive Industry from 2017 to 2022

Date of release	Title of policy paper	Secretary of State	Department
27 November 2017	The UK's Industrial Strategy	Rt Hon Greg Clark MP (Conservative Party)	Business Energy and Industrial Strategy (BEIS)
9 July 2018	Road to Zero Strategy	Rt Hon Chris Grayling MP (Conservative Party)	Department for Transport (DfT); and Office for Low Emission Vehicles (OLEV)
18 November 2020	The Ten Point Plan for a Green Industrial Revolution	The Rt Hon Alok Sharma MP (Conservative Party)	Business, Energy and Industrial Strategy
25 March 2022	UK Electric Vehicle Infrastructure Strategy	Rt Hon Grant Shapps MP (Conservative Party)	Department for Transport

Policy Priority in Policy Papers Creating a Market for Zero Tailpipe Emissions Vehicles in the UK

Policy paper	Policy priority linked with transformation of the automotive industry
The UK's Industrial Strategy	“support electric vehicles through £400m charging infrastructure investment and an extra £100m to extend the plug-in car grant”, making “25% of all cars in the central government department fleet ultra-low emission by 2022” (HM Government, 2017, pp. 50, 128)
Road to Zero Strategy	“put the UK at the forefront of the design and manufacturing of zero emission vehicles, and for all new cars and vans to be effectively zero emission by 2040” (Department for Transport, 2018, p. 2)
The Ten Point Plan for a Green Industrial Revolution	“end the sale of new petrol and diesel cars and vans from 2030”, “allow the sale of hybrid cars and vans that can drive a significant distance with no carbon coming out of the tailpipe until 2035” (HM Government, 2020, p. 14)
UK Electric Vehicle Infrastructure Strategy	installing a minimum of 300,000 public chargepoints by 2030, “but there could potentially be more than double that number” (Department for Transport, 2022, p. 44); standardisation of connectors of all devices on the UK public network (Department for Transport, 2022, pp. 5, 26).

An Overview of Vehicle Registration Statistics in the UK

From 2016 to 2022, the annual number of new EV registrations increased by **2077%**

In 2022, EVs accounted for **15.5%** of all new vehicle registrations in the UK

Between 2016 and 2022, the annual number of newly registered diesel vehicles decreased by **90%**

Over the same period from 2016 to 2022, the annual number of newly registered petrol vehicles decreased by **39%**

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Newly registered EVs, thousands	0.256	1.204	1.680	2.619	6.655	9.833	10.3	13.7	15.6	37.6	106.7	188.1	214
EVs, % change to previous year	41	370	40	56	154	48	5	33	14	141	184	76	14
EVs, % of all types of vehicles in the UK (including petrol and diesel)	0.01	0.06	0.08	0.12	0.27	0.38	0.39	0.55	0.67	1.64	6.59	11.47	15.5
Newly registered petrol vehicles, k	1061	925	968	1090	1174	1276	1313	1342	1460	1510	987	891	801
Newly registered diesel vehicles, k	913	959	1016	1102	1214	1253	1262	1048	736	604	295	188	123

Source: Department for Transport, 2022a; Department for Transport, 2022b

Agents/Activities Identified in the case of Transformation the Automotive Industry in the UK Between 2017-2022

Policymakers – *senior officials of the Department for Transport (DfT), Office for Low Emission Vehicles (OLEV), Department for Business, Energy & Industrial Strategy (BEIS); individuals involved in formulating, developing or amending policy*

Policy entrepreneurs – *directors of LowCVP; individuals who work from outside or inside the formal governmental system to introduce, translate, and implement innovative ideas into public sector practice (Roberts and King, 1991)*

Bricoleurs at the national level – *leaders of the Electric Vehicle Energy Taskforce (EVET) work packages; individuals who make suggestions for particular policies based on their knowledge, knowing which policy ideas the policymakers are ripe to, wherein they recombine policy ideas into bespoke policy solutions that fit a specific problem and which are capable of solving it (Deruelle, 2016)*

Knowledge brokers – *scientist; individuals who frame knowledge in order to be understandable in the political world (Zohlnhöfer & Rüb, 2016)*

Problem broker(ing) – *senior officials of carmakers, scientist; individuals who operate by connecting values, emotions and knowledge in order to frame a condition as a problem (Knaggård, 2015)*

Technology innovators – *senior officials of carmakers; individuals whose entrepreneurial activities related to the technology stream and focusing on the promotion the innovation by coupling “a technology narrative with a socio-political agenda” (Goyal, Howlett and Chindarkar, 2020)*

Electric Vehicle Energy Taskforce and Low Carbon Vehicle Partnership

Electric Vehicle Energy Taskforce (EVET) - collaboration platform that brings together policymakers, experts from the automotive industry, and energy sector to make a comprehensive set of proposals for Government and industry to ensure the electricity network is ready for the mass take-up of electric vehicles (Zemo Partnership, 2020)

The EVET Chair - senior representative from Energy Systems Catapult, a research and consulting organisation; within MSF context takes on the role of bricoleur

The EVET Secretary - senior representative from Low Carbon Vehicle Partnership, now known as the Zero Mobility Partnership (ZEMO); within MSF context takes on the role of policy entrepreneur

Low Carbon Vehicle Partnership (LowCVP, renamed as ZEMO partnership) – public-private partnership with primary objective to accelerate the EV transition in the UK

Project involved:

Amendments of the Renewable Transport Fuel Obligation

Consultations on the Road to Zero strategy

Secretary of Electric Vehicle Energy Taskforce

Agents/Activities in Multiple Windows of Opportunity, Multiple Streams and Industry Trajectories

Agent	What streams couple	In which stream work	In which level of the stream work	Inside or outside the government system	Type of leadership	Preference to a specific solution	Type of solution – technological or policy
Policy entrepreneur (ship)	Policy, problem, politics	Problem, policy, politics, industry trj.	National, incumbent, niche levels	Inside and outside	Appointed leadership	Has preference	Technological and policy solution
Bricoleurs (Bricolage)	Policy, problem, politics	Problem, policy, politics	National, incumbent, niche level	Inside and outside	Appointed leadership	In line with policymakers	Technological and policy solution
Knowledge brokers	na	Policy, industry trajectories	National, incumbent, niche levels	Inside and outside	na	No preference	na
Problem broker(ing)	na	Problem	National, incumbent, niche levels	Inside and outside	Appointed leadership	Has preference	Technological and policy solution
Technology innovators	Industry trajectories	Policy, problem, politics, industry trajectories	Incumbent, niche levels	Outside	Appointed leadership	Has preference	Technological and policy solution

Agency Within Multiple Types of Windows of Opportunity

Agency within Technological Window of Opportunity that was open in 2010 (tWoO-1) and 2016 (tWoO-2)

- **Agent and agency:** Technology Innovators, developing zero emission technologies
- **Coupled trajectories:** incumbent levels of energy supply (renewable energy, EV charging), incumbent levels of energy storage (li-ion batteries), and niche level of the automotive industry trajectories (EVs level)
- **Outcome:** the production of cost effective, mass market EVs with a decarbonised well-to-wheel process
- **Years:** 2010, 2016; Technological Window of Opportunity have a cumulative effect and can be considered as a coupling points which couple automotive, energy supply, and energy storage trajectories. In 2010, automotive industry trajectory was coupled with energy storage industry trajectory. In 2016, the automotive industry trajectory was coupled with the energy supply industry trajectory. The industry trajectories have not been not decoupled since then

Agency Within Multiple Types of Windows of Opportunity

Agency within Policy Window of Opportunity that was open from July 2016 to July 2018 (pWoO-1)

- **Agent and agency:** Policy Entrepreneurs at national level; informing Transport Energy Model and Road to Zero strategy
- **Policy solution:** 46-point policy plan in the Road to Zero strategy aiming to increase adoption of zero-emission vehicles
- **Coupled streams:** problem, policy, and politics streams at the national level
- **Outcome:** the inclusion 46-point policy plan in Road-to-Zero strategy; shifting the policy agenda from low emission targets to zero emission targets; setting targets for EV market uptake up to 2030
- **Duration of window:** July 2016 – July 2018 (24 months); The window opened when work commenced on the Transport Energy Model, this model informed Road to Zero strategy. The window closed with the release of the Road to Zero strategy in July 2018

Agency Within Multiple Types of Windows of Opportunity

Agency within Policy Window of Opportunity that was open from June 2018 to March 2020 (pWoO-2)

- **Agents and agency:**
 - Policy Entrepreneurs edit bespoke policy solutions and present them to the government;
 - Bricoleurs frame industry specific conditions as a problems, borrow Problem Brokers's frames, suggest policy ideas, and recombine their own policy ideas with those of technology innovators to create bespoke policy solutions. They mobilise industry stakeholder to accept the policy solution, present the bespoke policy solution to policy entrepreneurs, and amend policy solutions in response to policy entrepreneurs' comments;
 - Problem Brokers frame industry-specific conditions as problems, couple industry-specific problem with national social problems;
 - Technology Innovators pair policy ideas with technology solutions, share policy ideas with bricoleurs;
- **Policy solution:** four reports/policy solutions that include 21 policy recommendations;
- **Coupled streams:** problem, policy and politics streams at technological niche, incumbent, and national levels
- **Outcome:** inclusion of parts of the bespoke policy solutions in the final policy paper; release Smart Charging Regulation (including policy ideas from Policy Entrepreneurs) in 2021; release of the UK Electric Vehicle Infrastructure Strategy in 2022
- **Duration:** June 2018 – March 2020; policy window of opportunity opened when work on EVET work package initiated in June 2018 and closed upon its completion in March 2020

Agency Within Multiple Types of Windows of Opportunity

Agency within Problem Window of Opportunity at the Incumbent level (pbWoO)

- **Agents:**
 - Bricoleurs frame industry-specific conditions as a problems, seek policy solutions for industry these specific problems, and suggest industry-specific policy ideas;
 - Problem Brokers frame industry-specific conditions as a problems within problem stream;
 - Technology Innovators pair policy ideas with technology solutions, share policy ideas with bricoleurs;
- **Problem:** A lack of smart charging infrastructure, lack of interoperability in EV charging;
- **Coupled streams:** technological niche and incumbent levels of problem stream; technological niche and incumbent levels of policy stream;
- **Outcome:** pairing of industry-specific problem frames with corresponding industry specific policy and technology solutions;
- **Duration:** June 2018 – March 2020

Agency Within Multiple Types of Windows of Opportunity

Agency within Market Window of Opportunity

- **Agent and agency:** Technology Innovators; production technology, carrying out the necessary business operations
- **Coupled trajectories:** incumbent level of energy supply (renewable energy, EV charging), incumbent level of energy storage (battery) and incumbent level of automotive industry (EVs) trajectories
- **Outcome:** shift of EVs to incumbent level; begin market uptake by EVs
- **Year:** March 2022, increase the number of newly registered EV comparing with previous year by 184%; increase the proportion of newly registered EVs out of total to 6.59%. Market window of opportunity can be considered as tipping point that accelerates the growth of EV demand

Visualisation of the Multi-level Streams and Trajectories (MLST) Framework

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