Societal Readiness for Climate Solutions: Insights from Reddit Discourse on Adoption of Electric Vehicles, Plant-based Diets and Solar Photovoltaics

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ABSTRACT

Social media is where early clues of shifting climate norms and societal readiness for newest technologies now surface, yet no study has isolated –what people say in free form communication on social media. We present an AI enabled method to measure societal readiness for climate solutions using large scale Reddit discourse on electric vehicles (EVs), residential solar, and plant based diets. We combine manually derived frame taxonomies with GPT seeded annotation to train reproducible RoBERTa classifiers for sector specific frames and sentiment, released as open source models on Hugging Face. Our findings are: (1) recent EV discourse shows a higher share of anti sentiment than pro (anti = XXX %, pro = XXX %, p = XXX), while solar is more balanced (anti = XXX %, pro = XXX %, p = XXX) and veganism leans pro (pro = XXX %, anti = XXX %, p = XXX); (2) motivator level sentiment distributions reveal concentrated drivers, with EV pro sentiment led by environmental benefit (40 % pro, 29 % anti) and alternative modes (43 % pro, 35 % anti), and anti sentiment led by mineral supply chain (55 % anti, 12 % pro) and policy and mandates (43 % anti, 14 % pro); solar pro sentiment led by utility bills (54 % pro, 22 % anti) and anti sentiment by decommissioning and waste (52 % anti, 13 % pro); veganism pro sentiment led by taste and convenience (59 % pro, 18 % anti) and environmental impact (51 % pro, 21 % anti), with anti sentiment anchored in psychology and identity (40 % anti, 34 % pro) and animal welfare (40 % anti, 45 % pro); (3) comparison with survey data shows core motivators are shared but differ in prevalence, with Reddit under representing cost linked motivators such as EV purchase price (72 % survey vs 13.2 % Reddit) and solar utility bills (44 % vs 6.8 %), while surfacing emergent motivators absent from surveys such as solar grid stability and storage (30.3 %) and veganism systemic vs individual action (15.8 %). Advocates online are running ahead of public awareness, signaling where communication gaps lie. Social media can thus offer policy-makers an early-warning system for normative shifts and a reusable template for any emerging climate technology.

Introduction

Collective behaviours and social organisation are part of everyday life, and feeling part of active collective action renders mitigation measures efficient and pervasive [1]. Social and cultural processes play an important role in shaping what actions people take on climate mitigation, interacting with individual, structural, institutional and economic drivers [2]. Just like infrastructure, social and cultural processes can 'lock in' societies to carbon-intensive patterns of service delivery. They also offer potential levers to change normative ideas and social practices in order to achieve extensive emissions cuts (high confidence) (Table 5.4).

In terms of cultural processes, we can distinguish two levels of analysis: specific meanings associated with particular technologies or practices, and general narratives about climate change mitigation. Factors such as comfort, status, identity and agency are associated with many technologies and everyday social practices that deliver energy services, from driving a car to eating vegan food. Such factors are symbolic and influence the willingness of individuals to use existing technologies or shift to new ones [3–5]. Symbolic motives are more important predictors of technology adoption than instrumental motives [6–9]. If an individual's pro-environmental behaviour is associated with personal meaning than it also increases subjective well-being [10]. Status consciousness is highly relevant in GHG emission-intensive consumption choices (cars, houses). However, inversely framing energy-saving behaviour as high status is a promising strategy for emission reduction [11].

At a broader level, narratives about climate mitigation circulate within and across societies, and enable people to imagine and make sense of the future through processes of interpretation, understanding, communication and social interaction [12]. Stories about climate change can be utopian or dystopian (e.g., *The great derangement* by Amitav Ghosh) [13], for example presenting apocalyptic stories and imagery to capture people's attention and evoke emotional and behavioural response [14]. Reading climate stories has been shown to cause short-term influences on attitudes towards climate change, increasing the

belief that climate change is human caused and increasing its issue priority [15]. Climate narratives can also be used to justify skepticism of science, drawing together coalitions of diverse actors into social movements that aim to prevent climate action [16]. Narratives are also used in integrated assessment and energy system models that construct climate stabilisation scenarios, for example in the choice of parameters, their interpretation and model structure [17].

Power and agency shape which climate narratives are told and how prevalent they are [14, 15]. For example, narratives have been used by indigenous communities to imagine climate futures divergent from top-down, government-led narratives [18]. The uptake of new climate narratives is influenced by political beliefs and trust. Policymakers can enable emissions reduction by employing narratives that have broad societal appeal, encourage behavioural change and complement regulatory and fiscal measures [19]. Justice narratives may not have universal appeal: in a UK study, justice narratives polarised individuals along ideological lines, with lower support amongst individuals with right-wing beliefs; by contrast, narratives centred on saving energy, avoiding waste and patriotic values were more widely supported across society [20]. More research is needed to assess if these findings are prevalent in diverse socio-cultural contexts, as well as the role played by social media platforms to influence emerging narratives of climate change [21].

Trust in organisations is a key predictor of the take-up of novel energy services [22], particularly when financial incentives are high [23, 24]. Research has shown that if there is low public trust in utility companies, service delivery by community-based non-profit organisations in the US [23] or public/private partnerships in Mexico [25], offer more effective solutions, yet only if public trust is higher in these types of organisations. UK research shows that acceptance of shifts to less resource-intensive service provision (e.g., more resource-efficient products, extending product lifetimes, community schemes for sharing products) varies depending on factors including trust in suppliers and manufacturers, affordability, quality and hygiene of shared products, and fair allocation of responsibilities [26].

Action on climate mitigation is influenced by our perception of what other people commonly do, think or expect, known as social norms [27] (Table 5.3), even though people often do not acknowledge this [7, 28]. Changing social norms can encourage societal transformation and social tipping points to address climate mitigation [29, 30]. Providing feedback to people about how their own actions compare to others' can encourage mitigation [31], although the overall effect size is not strong [32]. Trending norms are behaviours that are becoming more popular, even if currently practiced by a minority. Communicating messages that the number of people engaging in a mitigation behaviour (e.g., giving a financial donation to an environmental conservation organisation) is increasing – a simple low-cost policy intervention – can encourage shifts to the targeted behaviour, even if the effect size is relatively small [33].

Socially comparative feedback seems to be more effective when people strongly identify with the reference group [34]. Descriptive norms (perceptions of behaviours common in others) are more strongly related to mitigation actions when injunctive norms (perceptions of whether certain behaviours are commonly approved or disapproved) are also strong, when people are not strongly personally involved with mitigation topics [35], when people are currently acting inconsistently with their preferences, when norm-based interventions are supported by other interventions and when the context supports norm-congruent actions [36]. A descriptive norm prime ('most other people try to reduce energy consumption') together with injunctive norm feedback ('you are very good at saving energy') is a very effective combination to motivate further energy savings [37]. Second-order beliefs (perceptions of what others in the community believe) are particularly important for leveraging descriptive norms [38].

Behavioural contagion, which describes how ideas and behaviours often spread like infectious diseases, is a major contributor to the climate crisis [39]. But harnessing contagion can also mitigate warming. Carbon-heavy consumption patterns have become the norm only in part because we're not charged for environmental damage we cause [40]. The deeper source of these patterns has been peer influence [41], because what we do influences others. A rooftop solar installation early in the adoption cycle, for example, spawns a copycat installation in the same neighbourhood within four months, on average. With such installations thus doubling every four months, a single new order results in 32 additional installations in just two years. And contagion doesn't stop there, since each family also influences friends and relatives in distant locations.

IPCC AR6 (WG III, Chapter 5) highlights a prominent knowledge gap in understanding of the dynamic interaction between individual, social, and structural drivers of change, particularly asking how social media influences the development and impacts of narratives about low-carbon transitions. Better understanding is required on: (i) more detailed causal mechanisms in the mutual interactions between individual, social, and structural drivers of change and how these vary over time, that is, what is their relative importance in different transition phases; (ii) how narratives associated with specific technologies, group identities, and climate change influence each other and interact over time to enable and constrain mitigation outcomes. (vi) a dynamic understanding of feasibility, which addresses the dynamic mechanisms that lower barriers or drive mitigation options over the barriers; The debate on the most powerful leverage points and policies for speeding up change in social and technological systems need to be resolved with more evidence.

Climate policy and technology adoption hinge not only on engineering breakthroughs but also on public engagement and support, and *societal readiness*–the degree to which populations are informed, interested, and supportive of climate solutions–has traditionally been assessed through structured questionnaires (e.g. Pew Research Center, 2022)[42], high-resolution opinion

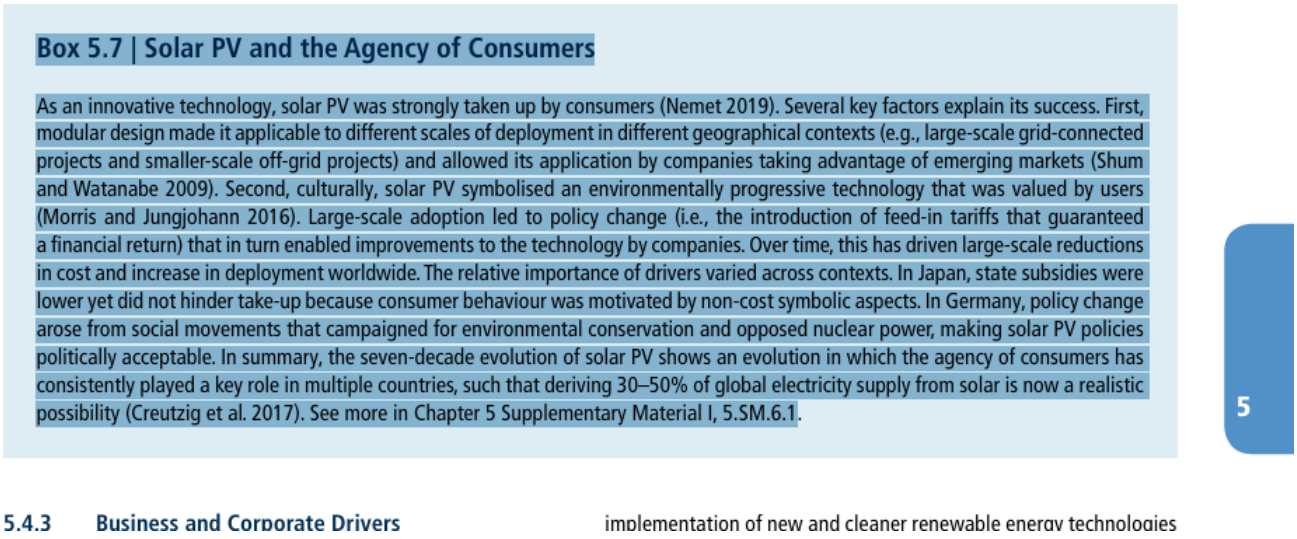

Figure 1. Enter Caption

maps (Yale Program on Climate Change Communication, 2023)[43], media content analyses (Boykoff & Roberts, 2007)[44], policy adoption indices (OECD, 2023)[45], technology deployment rates (IEA, 2023)[46], and social-media sentiment studies (Carlyle et al., 2021)[47]; despite their rigor, however, these approaches can be slow, costly, or limited in temporal resolution. To address these limitations, we propose a complementary, AI-enabled method that uses Reddit volumes as a real-time proxy for societal readiness, capturing emergent arguments and community attention that surveys might miss.

Here we leverage social media data and AI tools to address this knowledge gap. Using Reddit data from details copy paste

Research gap and contribution. To address the limitations of traditional readiness measures, we introduce a method combining new NLP method. First, we seed a multilabel frame taxonomy by manually defining sector-specific frames (from surveys and Reddit inspection), annotate 1,000 comments with GPT-4, and fine-tune a RoBERTa-base classifier–reporting accuracy and micro/macro Jaccard on held-out GPT labels. Second, we compare survey-based endorsement rates (Pew, Yale, Gallup) with the percentage of Reddit comments classified into each frame. Third, we construct a comment–frame incidence matrix, project it to a frame–frame co-occurrence network, generate a degree-preserving null model, compute z-scores for observed vs. null edge weights ($|z|>2$), and identify communities via Louvain clustering. Fourth, we surface emergent low-frequency narratives by filtering GPT-labeled frames beyond the top seven, and manually identifying novel frames with exemplar quotes. Finally, we provide a methodological appendix detailing GPT prompt design, RoBERTa fine-tuning hyperparameters, input formatting, threshold optimization, and the definitions of all evaluation metrics.

We believe social media data complement survey-data by shedding light on the relative importance of different factors driving the adopting a certain low-carbon lifestyle or technology. By capturing the attention level in form of number of comments on a certain factor, we can measure, we can quantify the collective importance given to it. So we compare 5 test questions from surveys on social media to show hte promise of AI methods applied to social media data to extract signal on command at near-zero cost and real time.

We analyzed Reddit discussions from 16 subreddits across three climate-related behavioral sectors: transport (*r/electricvehicles*, *r/ElectricScooters*, *r/Electricmotorcycles*), housing (*r/solar*), and food (*r/vegan*, *r/veganarchism*, *r/vegancirclejerk*), supplemented by nine general climate-related subreddits (*r/climate*, *r/ClimateActionPlan*, *r/climatechange*, *r/ClimateChaos*, *r/climatedisalarm*, *r/ClimateMemes*, *r/ClimateOffensive*, *r/ClimateShitposting*, *r/climateskeptics*). Posts and comments were filtered using regex patterns to identify sector-relevant content.

Results

Methods

Data

Identifying EVs, Solar and Vegan (Vegetarianism) discourse on Reddit data.

This methodology implements a keyword-based classification system to identify climate-related discussions within three major sectors: transport, housing, and food. The approach employs a comprehensive keyword taxonomy where each sector contains

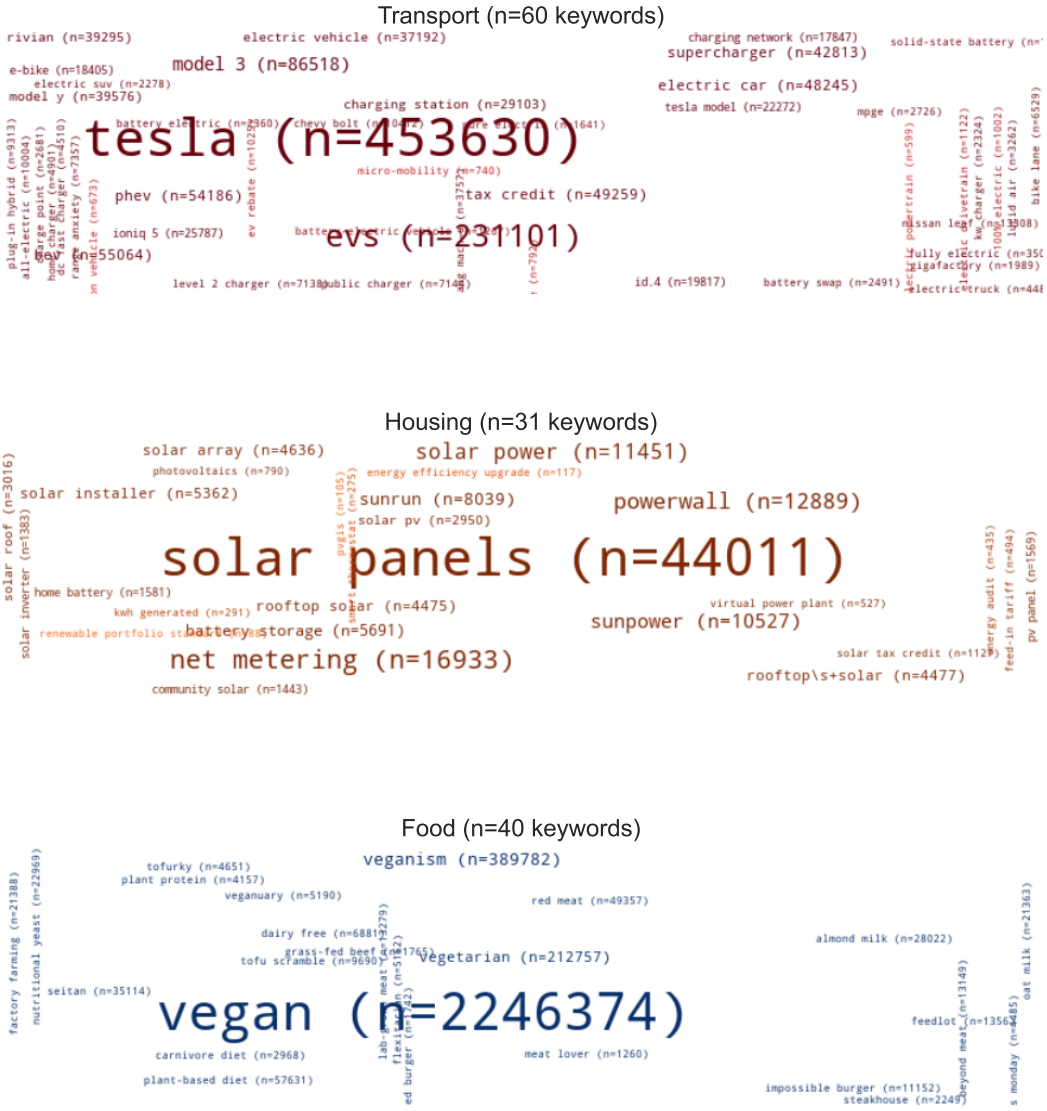

Figure 2. Keyword match frequencies across climate action sectors. Word clouds showing the number of matches found for each chosen keywords associated with climate discussions in three sectors: Food (vegetarianism), Housing (solar), and Transport (EVs).

domain-specific terminology and related concepts that indicate sector-relevant content within climate change discourse.

The transport sector lexicon includes electric vehicle terminology such as "ev", "electric vehicle", "evs", "bev", "battery electric", "battery-electric vehicle", "tesla model", "model 3", "model y", "chevy bolt", "nissan leaf", "ioniq 5", "mustang mach-e", "id.4", "rivian", "lucid air", "supercharger", "gigafactory", "zero emission vehicle", "zero-emission vehicle", "pure electric", "all-electric", "fully electric", "100% electric", "electric powertrain", "electric drivetrain", "electric motor vehicle", "level 2 charger", "dc fast charger", "public charger", "home charger", "charging network", "range anxiety", "mpge", "bike lane", "protected cycleway", "car-free", "low emission zone", "electric car", "electric truck", "electric suv", "plug-in hybrid", "phev", "charging station", "charge point", "kw charger", "battery swap", "solid-state battery", "gigacast", "tax credit", "zev mandate", "ev rebate", "phase-out ice", "e-bike", "micro-mobility", "last-mile delivery", "transit electrification", "tesla", "spacex launch price", "elon says", "rail electrification", "hydrogen truck", and "low carbon transport".

The housing sector lexicon focuses on solar energy systems and residential efficiency with terms including "rooftop solar", "solar pv", "pv panel", "photovoltaics", "solar array", "net metering", "feed-in tariff", "solar inverter", "kwh generated", "solar roof", "sunrun", "sunpower", "solar panel", "solar panels", "solar power", "photovoltaic", "photovoltaics", "solar installer", "battery storage", "powerwall", "home battery", "smart thermostat", "energy audit", "energy efficiency upgrade", "led retrofit", "green home", "net-zero house", "zero-energy building", "solar tax credit", "pvgis", "renewable portfolio standard", "community solar", "virtual power plant", and "rooftop rebate".

The food sector lexicon targets dietary choices and agricultural emissions with terms such as "vegan", "plant-based diet", "plant based", "veganism", "veganuary", "vegetarian", "veg lifestyle", "carnivore diet", "meat lover", "steakhouse", "barbecue festival", "bacon double", "grass-fed beef", "factory farming", "meatless monday", "beyond meat", "impossible burger", "plant-based burger", "animal cruelty free", "red meat", "beef consumption", "dairy free", "plant protein", "soy burger", "nutritional yeast", "seitan", "tofurky", "agricultural emissions", "methane footprint", "carbon hoofprint", "cow burps", "livestock emissions", "feedlot", "recipe vegan", "tofu scramble", "almond milk", "oat milk", "flexitarian", "climatetarian", "cultivated meat", "lab-grown meat", and "precision fermentation".

The classification process utilizes regular expression (regex) pattern matching with case-insensitive search to identify sector-relevant comments from the corpus. Each keyword is converted to a flexible regex pattern that accommodates morphological variations including plural forms, optional hyphens, and flexible whitespace. The total matches of each keyword search for the 3 sectors are shown in Fig. 2. The total corpus comprises XXXXXX transport comments (EVs), XXXXXX housing comments (solar), and XXXXXX food comments (vegan/vegetarianism).

Data availability

The data used in this work is openly accessible for download at XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.

Code availability

The code used in this study is available at XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX.

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Author contributions statement

S.C. and S.E. conceived and designed the study. S.C. conducted the data analysis. S.E. and S.C. interpreted the results. S.C. wrote the manuscript. S.E. provided feedback on the manuscript.

Additional information

The authors declare that they have no competing interests.