FAIRTRANS (Fair Transition to a fossil Free Future)

Program Plan Phase 1 (2021-2025)

Part A

Summary

The overarching objective of the proposed programme is to promote transformations to a fair and fossil free future (FAIRTRANS). We will co-create roadmaps for staying within the remaining carbon budget according to the Paris Agreement together with trade unions and other large Swedish popular movement organisations (PMOs) with over 3 million members. The interests, jobs and wellbeing of ordinary citizens are often perceived as threatened by the ongoing digital revolution (WP4) and higher fuel prices. FAIRTRANS proposes to co-create a science-based policy framework with these large PMOs to facilitate rapid yet resilient decarbonisation strategies and policies (WP5). Input legitimacy is inherent in our approach and output legitimacy is achieved through effective, cost-efficient and fair transformative strategies and policies with long-term, lasting impacts.

Transformations require technological transitions and we will calculate comprehensive national roadmaps, taking into account a globally fair national carbon budget (WP1) and trade-offs with other planetary boundaries and SDGs (WP2). This is compared with the sector-wise roadmaps that dominate the public discourse, which risk overestimating e.g. the supply of biomass and not analysing distribution effects (WP2). Recent research, and also the UNDP and the EEA, have concluded that sustainability transformations need to go beyond technical transitions and re-consider visions for sustained quality of life which are not contingent on GDP growth. FAIRTRANS therefore explores scenarios for decoupling, rebound effects and how this influences a rapid and fair climate transformation (WP2).

Green negative emission technologies (NETs) are part of the EU's new 55% emission reduction target and FAIRTRANS will explore scenarios, together with key stakeholders, for increasing and sustaining carbon sinks of forests (WP3). We will also collaborate to develop a digital platform and a voluntary market for incentivising carbon sequestration in agriculture, with sustainable farming as co-benefit (WP3).

The impact of digital revolution on society is shaping the prospect of achieving the objective of FAIRTRANS. In WP4 we engage in production of scientific knowledge for ensuring digital climate action that is fair and inclusive, while we develop new digital tools to capture broad-based societal attitudes towards transformation in Sweden and the EU. We also use an inside perspective on emergent behavioural shifts in society due to remote work and digital commons that has accelerated during the pandemic. In combination, our approach to digitalization attempts to obtain new knowledge that can facilitate co-creation of a discourse and policy for a fair and rapid decarbonisation.

A wide array of Civil Society Organisations (CSOs) will co-create knowledge with researchers in WP2-5. One partner, the politically independent think tank Global Utmaning, has already enrolled large PMOs in collaborations for a climate agenda and FAIRTRANS will benefit from the trust and knowledge that has already been established. FAIRTRANS has engaged additional large PMOs and CSOs. A key focus is on understanding barriers and opportunities for fair transformations, and co-developing governance strategies and policies

together with PMOs and other CSOs (WP5). We will also engage with PMOs to develop strategies for action and learning, to ensure that their members are included and can benefit from the transformations. Expected impacts include a distinct reduction of the present societal polarisation, increasing legitimacy for rapid decarbonisation, and a new societal contract that is scientifically credible and socially legitimate.

The programme management includes researchers from the natural sciences, political science, economics, social sciences and sustainability science, with an excellent track-record of science-policy research with CSOs, professional communicators and a board with outstanding experience and insights into the Swedish governance system.

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1. Visions, aims and expected impacts

FAIRTRANS is founded on a realist philosophy where Earth's biosphere, including the climate system, is a foundation for human wellbeing. This foundation is under threat by today's global social and economic systems. In our view, equitable and fair human development can only take place within a just and safe operating space (Steffen et al. 2015; Raworth 2017), recognizing Planetary Boundaries (Rockström et al. 2009). This view is endorsed by the UNDP in its Human Development Report (UNDP 2020) to which some of us contributed. There is growing scientific understanding that "(in)equity and (un)sustainability are produced by the interactions and dynamics of coupled social–ecological systems" (Leach et al. 2018). Real system-wide transformation is needed.

The vision for FAIRTRANS is to contribute nationally and internationally to a fair societal transformations that help to realise the Paris Agreement, based on scientific knowledge and respect for planetary boundaries and social goals. The goal of the Paris Agreement is to keep global average temperature well below 2 °C above pre-industrial levels and to pursue efforts to limit the increase to 1.5 °C. From this goal, national carbon budgets can be developed, contingent upon assumptions about negative emission technologies and global fairness principles. The UNFCCC principle on common but differentiated responsibilities and respective capabilities is scale-free but since we assume that the remaining carbon budget is strikingly small, transformation necessitates pervasive strategies and policies, which call for stakeholder and citizen dialogue on how to understand "fair" in a global as well as national context.

Our mission is to develop science-based and fair roadmaps for rapid decarbonisation, consistent with the Swedish carbon budget, through collaboration with key actors from civil society.

We account for social diversity and macro-economic issues in the following ways. A macro-economic analysis will especially be conducted in WP 2: Budgeting a Fair Transformation, but macro-economic issues will also be discussed in WP1 and WP3. We will collaborate with different kinds of civil society organisations (CSOs) and popular movement organisation (PMOs) framed by different ideologies ranging from think tanks, unions, nature associations, cooperatives, corporate networks and private enterprises. While CSOs are the prime focus of FAIRTRANS, both land owners transnational corporations (TNCs) are included in the programme. We engage with individual land owners especially in WP3 and TNCs (through Fossil Free Sweden) in WP2. LRF and Ericsson are represented in the board. Social diversity is also accounted for the organization of FAIRTRANS. Here diversity is accounted for in terms of gender, age and ideology. We have considered gender equality related to influence over programme development. Since the program directors both are males, the head of the board is female. Since we have more males than females as WP leaders, the majority of board members are females. Since most collaborators are middle-aged or older, we include the chair of Fältbiologerna in our board. Hence the program explicitly uses diversity as a strategy for transformation.

FAIRTRANS distinguishes between transformation and adaptation. Adaptation is about adjusting responses to changing external drivers and internal processes and thereby allows for resilience and development along the current trajectory (Folke et al. 2010). Transformation, on the other hand, implies undermining the resilience of the present system to break with some of the existing structures. This is often referred to as crossing a threshold or shifting to a new regime. Transformative governance seeks to deliberately shift to more desirable regimes by altering the system-defining goals, structures and processes (Walker et al. 2004; Chaffin et al. 2016). The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services defines transformative change as a "fundamental, system-wide reorganization across technological, economic and social factors, including paradigms, goals and values" (IPBES 2019). IPBES argues that transformative changes are "more likely when efforts are directed at […] key leverage points, where efforts yield exceptionally large effects: (1) visions of a good life; (2) total consumption and waste" (p. 9). This means "steering away from the current, limited paradigm of economic growth... reducing overconsumption and waste" (p. 10).

Sustaining the resilience of Earth's biosphere requires far-reaching transformations of the economy, breaking path dependency and shifting toward a new development trajectory defined by a fundamentally different narrative (Hahn & Nykvist 2017). FAIRTRANS focuses on **deliberate and fair societal transformations to safeguard a resilient climate system and secure sustained and resilient delivery of ecosystem services.** There is a growing recognition of the dramatic socio-cultural, political, economic, and technological changes required to move societies toward more desirable futures (Pereira et al. 2019). Real transformations result from fundamental changes in human and political vision, planning, and action that offer new configurations of social-ecological systems (Westley et al. 2013).

In this framework, the EU Green Deal should become a strategy for transformation. An agenda focused on green growth risks perpetuating, and thereby adapting to, today's growth paradigm, which impedes a real transformation (Olsson et al. 2017). The empirical fact that economic growth increases resource use and in general increases CO_2-emissions needs to be taken into account; each action in the Green Deal needs to be carefully analysed in terms of its effects on the climate, environment, jobs and sustainable development. The growth of green technology enables shrinkage of fossil-intensive technology, but such "creative destruction" (Schumpeter 1942) is met with resistance from major economic actors investing in business-as-usual (BAU) (EASAC 2020). New technologies and green jobs are necessary for the needed climate transformation, but risk being co-opted by the growth paradigm, which generates rebound effects and therefore results in less and slower emission reductions (Hickel & Kallis 2020). The digital transformation is guided by intended as well as unintended policy choices, and involves both threats and opportunities (TWI2050 2019). The converging, step-change innovations of the digital revolution ("the Fourth Industrial Revolution") needs to be managed by overarching climate policies for the sustainability transformations needed to achieve the Paris accord.

Building a better future will require an ability to anticipate how societies, economies, and ecosystems are linked across scales, and will likely require the fundamental alteration of prevailing human–environment relationships (Bennett et al. 2016). Transformation is a concept that can support the articulation of diverse aspirations for change in human society towards more sustainable and equitable global futures (Leach et al. 2010, Moser 2016, Patterson et al. 2017). A first step in a transformation framed by a national carbon budget is to understand the scope of the changes needed to mitigate climate change without further breaching other planetary boundaries. In WP1, FAIRTRANS aims to develop and share a comprehensive social-ecological-technical systemic understanding about the remaining global and national carbon budgets, acknowledging alternative fairness principles and different assumptions for negative emission technologies (NETs). A second step (WP2) is to assess the real scope for decarbonisation and how this relates to decoupling and rebound effects. The aim of WP2 is to improve understanding of conflicting discourses and paradigm and develop realistic and fair scenarios for investments and consumption within the national carbon budget.

The budgets and scenarios from WP1-2 provide the basis for co-creating a new discourse for Swedish climate governance and policy. Partner civil society organisations (CSOs) have 3-4 million Swedish members. With academics and CSOs working together, WP3 and WP4 explore a set of climate-critical topics related to issues of fairness, digitalisation and land-use. Knowledge and strategies will be co-developed with key stakeholders. The outputs from WP1-4 will continuously be utilized in WP5 to co-create - with popular movement organisations and other CSOs - improved mutual understanding, resulting in exploration and development of innovative governance and policy options. Sectoral roadmaps consistent with the Swedish carbon budget will be assessed to identify barriers and drivers for strategies and policies on e.g. investments, consumption and bioenergy, and to catalyse effectual socio-ecological-technical transformations that are seen as legitimate.

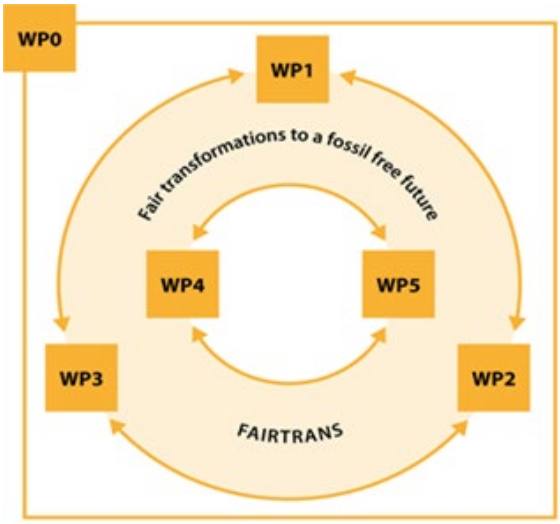


Figure 1. The doughnut of FAIRTRANS. WP1-3 develops understanding and scenarios for decarbonisation. WP4 aims at shaping the ongoing digital revolution so that it promotes fair transformations while WP5 focuses on "getting it done," by co-developing governance and policy frameworks with high input and output legitimacy. WP0 is about coordination, administration and communication of FAIRTRANS. The illustration is inspired by the Raworth's "Doughnut" symbolizing an environmental 'ceiling' and a social 'floor' (cf. Raworth 2017).

The lasting impact of FAIRTRANS will be a shift in society's discourse about what a transformation to a fossil-free society entails. Issues of fairness, democracy and ecological resilience have not been prominent in Swedish climate policies, but many local and culturally evolved practices and traditions of various CSOs could be harnessed toward delivering on the Paris Agreement (Colding et al. 2020). Involving citizens and CSOs in co-creating sustainable visions and roadmaps is a multiplier of knowledge and action for effective transformation. Hope is a function of action; when people understand the challenges, see how policy changes and how they actively can become part of the solutions, then they have reasons for real hope. The co-created transformation policies will accommodate a diversity of visions, set out concrete action plans which are attractive to different people and organisations, and be perceived as legitimate by several large and diverse CSOs. We expect that such a shift in discourse in society will also support politicians in taking necessary steps towards fulfilling the Paris Agreement and extending Sweden's influence in international arenas. Scientific impact will be the creation of a novel research frontier on social-technical-ecological transformations for a fair and decarbonized world.

2. Scientific value of the programme

2.1 Identified gaps in the state of the art

Climate neutral socio-economic development is essential to reach the Paris targets, but may not be enough to stay clear of dangerous Earth system tipping points. Clearer analysis is needed of ways that humanity can both reduce greenhouse gas emissions and simultaneously develop strategies to avoid passing other thresholds in key Earth system processes (Dearing et al. 2014, Steffen et al. 2018). Transdisciplinary Earth system science aims to understand the structure and functioning of the Earth as a complex adaptive system (CAS). State-of-the-art Earth system science now shows that if boreal, temperate and tropical forests tip to savannah or degraded forests, they can rapidly go from being important global carbon sinks and stocks to becoming carbon sources, undermining global goals of carbon neutrality (Steffen et al. 2018). Whether or not such shifts will occur depends

on ecological and climatic feedbacks operating on different scales, as well as the ways in which scale-crossing (telecoupling) human activities such as land-use change interfere with them (Scheffer et al. 2015).

Future Earth's 2019 Exponential Roadmap presented "36 economically viable solutions to cut global greenhouse gas emissions 50% by 2030 and the strategies to scale this transformation" (Falk et al. 2019). These solutions need to be crafted in a national context, taking cross-scale coupling into account where possible. A FAIRTRANS subcontractor has just started this effort (Material Economics 2021). Evidence indicates that just as climate benefits are exported (mainly wood products), CO2 emissions from Swedish imported consumption are also exported. Clearer analysis is required of spillover effects of regional consumption patterns on impacts elsewhere (Kere & Kinda 2016, Tinta et al 2018).

With current policies, total CO2 emissions for Sweden would be around 800 Mt CO_2 until 2100, more than double the Paris-compliant carbon budget according to an estimation by Anderson et al. (2019). Recent inclusive modeling suggests that it is still possible to deliver Sweden's climate policies and achieve SDG targets for biodiversity, water protection, and health until 2050, while respecting the national fair share planetary boundaries (Basnet et al 2020 in FABLE Report 2020), but this remains to be done in practice. The challenge of a fossil-free welfare society meeting all SDGs has never been thoroughly addressed at national scale, although it is aligned with the "Doughnut economy" (Raworth 2017), recently embraced at city level by Amsterdam. O'Neill (2018) shows that countries fulfilling most SDGs today are the biggest contributors to transgressing the planetary boundaries. Attempts to "downscale" planetary boundaries as national fair shares have been made, but are highly sensitive to allocation principles (Häyhä et al. 2016, 2018).

The importance of investments in real capital for transforming unsustainable production and consumption has been highlighted in recent research. Investments in areas like clean physical infrastructure, building efficiency retrofits, education and training, natural capital, and clean R&D can achieve both economic revitalization and climate goals simultaneously (Engström et al. 2020). However, there is a lack of frameworks, studies and models for analysing which investments to prioritise in order to achieve the dual goal of reducing emissions and equitably achieving future welfare and a sustainable level of consumption. We have previously shown that investments for a climate transformation, e.g. renewable energy, will consume most of the carbon budget, leaving a very small carbon budget for consumption (Alfredsson & Malmaeus 2019). Integrative modeling methods that better capture biophysical systems can provide new scientific knowledge of the interplay between the technical, economic, social and environmental aspects of the world through the lens of sustainable investments.

The links between climate action, sustainable development and economic growth need attention. A conclusion from bibliometric mapping is that "large rapid absolute reductions of resource use and GHG emissions cannot be achieved through observed decoupling rates" (Haberl et al. 2020). However, for some regions and some periods it is possible, e.g. the EU experienced absolute decoupling of territorial emissions 1990-2014, although the rate of decoupling is insufficient to reach Paris Agreement. Technological solutions to sustainability challenges often result in problem shifting, cost shifting or rebound effects (Parrique et al. 2019) and unforeseen wicked problems (Colding et al. 2020). Producing things with higher resource efficiency reduces prices (in a competitive economy) and therefore does not cause an increase in GDP (Malmaeus 2016). It is the rebound effect, e.g. increased consumption, which generally causes GDP increases. Our previous research suggests that the technical potential is high for a rapid decarbonisation if policies and investments are coordinated across sectors and massive investments in solar and wind power is substituted for bioenergy (Material Economics 2021). These technological scenarios need to be merged with Earth System Science and economic scenarios to understand ecological and control rebound effects.

Nobody has shown how a rapid decarbonisation, catalysed by technological development and innovations including a rapid digitalisation, can control rebound effects which would otherwise "consume" much of the

efficiency gains. The often-used Shared Socioeconomic Pathways (SSPs), the basis for IPCC climate scenarios, all assume continued global and regional GDP growth, even the Decarbonized Pathway SSP1. This contrasts with the growing scientific understanding that effective sustainability transformation requires profound changes in consumption patterns, especially for the rich, complementing technological advancements and challenging the present structural imperative for growth (Wiedmann et al. 2020). Schandl et al. (2016) found that a strong policy scenario has significant potential, in relation to BAU, to reduce carbon emissions and material footprint with continued high GDP growth. However, their most optimistic policy scenario would only stabilise global carbon dioxide emissions, not reduce them, due to the rebound effect.

The direct environmental effects of digitalization are caused by production, use and disposal of hardware. However, when rightly used, important efficiency gains could potentially be harnessed from information and communication technology (ICT). The *Global e-Sustainability Initiative* estimated that digitalisation based on ICT can help reduce global greenhouse gas emissions by 20 percent by 2030 (GeSI 2015). While gaps exist on the direct environmental gains of digitalisation, there are also critical gaps that need to be addressed concerning its indirect social effects. For instance, equity and democratic issues have been understudied when it comes to societal consequences of digitalization (Colding et al. 2019).

Since goal-oriented transformations involve reconsidering political objectives, or even complete reconfiguration of existing systems and ways of doing things, they need to actively include participation of a diverse range of stakeholders (Pereira et al. 2019). Scientific understanding of the kinds of transformations that are needed and what interventions might get us there is a good start, but the solution space also needs to take account of people's attitudes to transformation (Sörqvist et al. 2020). Whilst the policy discourse on these issues can be shaped by surveys and interaction with various stakeholders, bringing together key stakeholders and ensuring that marginalised voices are adequately heard requires a more interactive process of knowledge co-production through the design of transformative spaces (Pereira et al. 2019).

Transformative spaces are "safe enough" collaborative environments where actors invested in transformation can experiment with new mental models, ideas, and practices that can help shift social-ecological systems onto alternative pathways. They enable dialogue, reflection, and reflexive learning, while reframing issues in ways that allow solutions to be co-created and co-realized, whilst recognising that conflict is part of the journey. As such, transformative spaces are solution-oriented; they deliberately seek a variety of perspectives aside from those usually dominant and operate as stepping stones for systemic transformation in specific contexts (Pereira et al. 2019). The novel contribution of such processes to transformation, include experimental methods, a transdisciplinary model of research, scalability and transferability of results, as well as scientific and societal learning and reflexivity (Schäpke et al. 2018). There are many examples of co-produced spaces for enabling sustainability transformation, including T-labs (Charli-Joseph et al 2018) but they have been developed at a national level with the aim of enabling a fair fossil free society, a gap we will fill.

2.2 The FAIRTRANS approach to the four focus areas

FAIRTRANS will address all focus areas (transformation, equality, digitalisation and civil society) identified by the MISTRA background paper (Höjer et al. 2020), by researching and promoting fair transformations toward a fossil free future, with civil society engagement and digitalisation as the main vehicles for change.

First, civil society organisations are widely recognized to have great potential to drive social change (Fligstein & McAdam 2011). For example, civil society initiatives can pioneer new social relations and practices and can therefore be an integral part of societal transformations; they can also fill the void left by a retreating welfare state, thereby safeguarding and servicing social needs but also backing up the welfare state. In addition, they can act as a hidden innovator—contributing to sustainability (Frantzeskaki et al. 2016). Scholars tend to agree that the state and civil society are different, with civil society being somewhat autonomous from the state. The

boundary between the two is, however, not a rigid one given the many hybridized forms of CSOs that have emerged. Hence, the relationship between organizations that represent civil society and the state are diverse, ranging from contestation to coalitions and partnerships that help provide state services (Frantzeskaki et al. 2016). FAIRTRANS adopts a broad definition of CSOs, which includes both NGOs (e.g. non-profit and voluntary organizations) and vested interest groups like trade- and labor unions and cooperatives.

Swedish CSOs are heavily dominated by popular movement organizations (PMOs), which are characterised as democratic nonprofit membership organisations. This differs from the charity and voluntary tradition in Anglo-Saxon countries or the social economy paradigm which is strong in French-speaking countries (Hvenmark & Wijkström 2004). The Swedish PMOs illustrate what DiMaggio and Powell (1983) refer to as an institutionalized organizational field with a prominent role in the legal and political landscapes. Despite PMOs being democratic organisations with elected representatives, often enjoying high status in sustainability issues, the ways PMOs can influence their members, and thereby a large part of the population, have rarely been addressed in research (Parek & Klintman 2021). FAIRTRANS involves both small and large PMOs (trade unions, housing associations, environmental and nature protection organisations, and consumer coop) in the research process as well as in policy development and policy implementation. This is what co-creation is about in FAIRTRANS. Other types of CSOs involved include organisations and networks for investors, self-organized digital remote co-working spaces and businesses.

Secondly, information and communication technology (ICT) can be a key driver behind improving energy efficiency, accelerating decarbonization and improving people's quality of life. Digital technologies also pose universal impacts on current societies and expose people to a range of new possibilities and previously unknown challenges. While ICTs provide many benefits for climate action, they also need to be socially sustainable. Scientific knowledge about potential wicked problems of digital development is critically important in order to succeed with co-creation of an effective climate roadmap that is perceived as fair and that strongly motivates civil society organisations. We critically analyze the direct and indirect roles of digital development in all our WPs, but explicitly in WP4, where we engage in critical scientific production on how digital development impacts on issues of fairness and climate action. FAIRTRANS at the same time utilizes up-dated digital tools such as web-surveys, remote work technologies, machine learning, web-crawlers in scientific methods in our co-creation work.

Third, we focus our analysis on fairness, embedding discussions about perceived legitimacy and what is fair as part of the design of the whole programme. Input legitimacy emphasizes issues like participation, transparency and accountability (Bäckstrand 2006) while output legitimacy (Vatn et al. 2017) in this case includes fairness (globally and nationally), effectiveness (rapid decarbonisation), and cost-effective transformation. Input legitimacy is enhanced through co-creation of knowledge and visions. While concepts such as equality and equity overlap and mean different things in different contexts, we focus on ‘fair’ and ‘fairness’, denoting both fair procedures (input) and fair distribution (output) of goods and services that affect well-being, which includes psychological, physiological, economic, and social aspects (Kabanoff 1991). Achieved fairness and perceived legitimacy are important for climate policy (Ringius et al. 2002) and are intertwined into the design of WPs 2-5. This is of particular importance in WP5 where policy development is co-created by interactions with CSOs. In particular, the large PMOs involved represent over 3 million members, a large subset of the Swedish population. The PMO leaders involved in FAIRTRANS policy dialogues are accountable to their members.

Fourth, transformation is rapidly emerging as a key concept in the sustainability discourse. Transformations concern social responses to perceived crises and generally require “radical, systemic shifts in deeply held values and beliefs, patterns of social behavior, and multi-level governance and management regimes” (Chaffin et al. 2016). This departs from the more limited understanding of “socio-technical transitions”, which focus on system components such as technology, energy, markets and policies (Geels 2002). Transitions often start as innovations at the local “niche” level, influencing institutions (“regimes”) and finally impacting society more

widely (“landscape”). Lately the socio-technical transition literature has included social and political dimensions, value conflicts, power struggles and resistance (Geels 2014), becoming more similar in scope to the transformation literature.

Scoones et al. (2020) distinguish between three approaches to transformations: (i) the structural approach emphasises radical changes in underlying political, economic and societal structures and drivers, often taking advantage of crises and mobilisation of civil society; (ii) the systemic approach identifies system components, dynamics, non-linear responses and resilience, increasingly giving attention to social dimensions and contexts such as power and institutions; and (iii) the enabling approach highlights the agency and uncertainties inherent when considering objectives and directions for transformative change. Much resilience literature is systemic: “[t]ransformability is the capacity to create a fundamentally new system when ecological, economic, or social structures make the existing system untenable” (Walker et al. 2004). However, our previous work on Planetary Boundaries and with social-ecological transformations and within IPBES are well-situated in the structural approach, emphasising the role of crises, “policy windows'', social networks and indirect (underlying) drivers. Our previous research on agency, leadership, trust-building, as well as horizontal and vertical networking with diverse stakeholder groups situates our work within the enabling approach, where there is a particular concern to enhance the capacity of different groups and individuals to mobilize, participate, voice their interests and implement change. This enabling approach will be highlighted in this programme, where we will create conditions for great opportunities to engage in T-labs, study circles and other forms of dialogues with key Swedish PMOs.

3. Benefits of the proposed programme to society

FAIRTRANS will help Sweden take climate leadership by developing transformative strategies and policy proposals and through mobilisation together with civil society. Sweden’s overarching climate target is to reach net-zero emissions of greenhouse gases by 2045, followed by net-negative emissions thereafter. Neither this goal nor interim goals will be achieved if current conditions and existing policies continue, according to the government’s independent Climate Policy Council (CPC 2020). The rate of territorial emission reductions is simply to slow. The CPC explicitly notes that the Swedish government’s policies are not assessed in relation to their effects on emissions. Besides, early reductions have much better climate benefits than later. This is why our proposal strongly emphasises carbon budgets.

According to Anderson (2018), Sweden’s remaining fair Paris 2°C fossil carbon budget is between 300 and 600 million tonnes of CO_2 from 2018, which means 6 to 12 years given current emissions. However, no public actor has so far presented a national coherent carbon budget based on Earth system science understanding, let alone using globally and nationally fair and transparent allocation principles, or showing pathways for how to stay within such a budget. The EU’s new binding target (Dec 2020) is to reduce GHG emissions by at least 55% in 2030, compared to 1990. At least 50% of this must be fossil (black carbon), maximum 5% may be green NETs. Countries representing two thirds of global emissions (China, USA, Japan, EU, South Korea and India) have targets to become carbon neutral (including NETs) by 2050, or 2060 for China. A policy-relevant understanding of the role of biosphere feedback is essential if these climate targets are to be met.

The focus in Sweden has with few exceptions been placed on overall or sector-by-sector goals, with insufficient implementation, without much inclusion of civil society, and with too weak emphasis on distribution effects, e.g. the latest climate bill (2019/20:65). As part of the government initiative Fossil Free Sweden, 22 different industry branches have produced their own roadmaps to show how they can enhance their competitiveness by going fossil free or climate neutral. One question though, is if the increased bioenergy demand of the magnitude 100 TWh associated with these roadmaps can be produced sustainably. Fossil Free Sweden includes all carbon-intensive industries in Sweden and has therefore a key role for the transformation analysed in FAIRTRANS. We

have enrolled the government's coordinator Svante Axelsson to participate in analyzing these roadmaps in the context of carbon budgets and our own results on a national roadmap (Task 2.2).

The 2018 Swedish Climate Law is firmly embedded in and contingent on the GDP growth paradigm. The Parliament approved the Climate Law with the condition that climate politics should be efficient and "that reduced emissions of GHG should be combined with economic growth" (MJU 2016/17). With this framing, not even effective, efficient and fair climate politics may jeopardize GDP growth. Such a position has no support in economic theory, in that efficiency increases when external costs are internalised by carbon pricing, even if this results in lower GDP.

The unique approach that FAIRTRANS employs to cope with societal dilemmas for a fair climate transformation is that knowledge and policy processes are co-created with large popular movement organisations (PMOs) and other CSOs, ensuring a broadly anchored process. Hence FAIRTRANS embraces the whole link from a globally fair carbon budget and how industry transforms according to this, to analysing and facilitating broader societal transformations. We use the concept of co-creation as an approach to generate knowledge and understanding through education, joint problem solving, and in particular dialogue across academic disciplines and between academics and organizations outside of academia (Tengö et al. 2017). In such co-creation processes, underlying values associated with represented knowledge traditions will be put forward in dialogues (Raymond et al. 2019).

After four years FAIRTRANS collaborators have co-created strategies and policies for fair transformations based on a common understanding of Sweden's globally and nationally fair carbon budget. FAIRTRANS has shaped debates in climate transformation to include issues of digital inequalities, and reduced commuting by supporting fossil free digital remote work commons in Sweden. Key actors are beginning to understand that the massive investments in infrastructure put a limit on the carbon footprint of private consumption. FAIRTRANS has organized science-based stakeholder dialogues and reduced the present polarisation in the forestry and bioenergy debates. FAIRTRANS has scientifically explored climate governance and policy and showed how to overcome barriers and strengthen drivers for transformation. FAIRTRANS has established trust and shared visions among CSOs who previously had not much in common and engaged in deliberations on policy proposals. A social contract and joint vision is formulated in The Climate Manifest, coordinated by FAIRTRANS at the end of the programme time. After eight years the education of hundreds of climate "ombudsmän" (*eng.* local climate representatives) within PMOs representing over 3

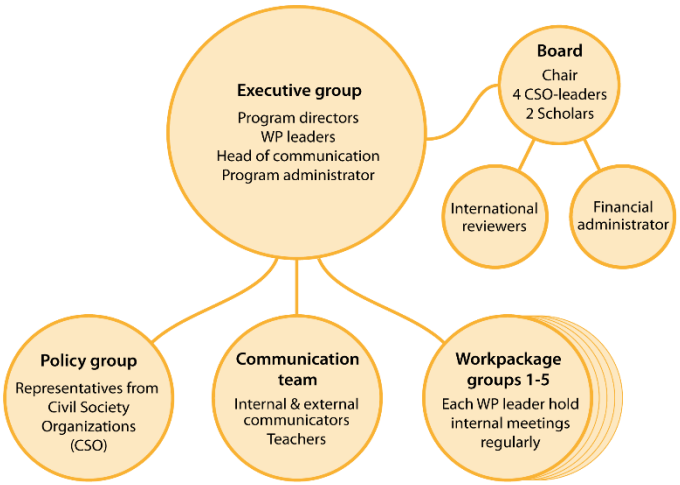
million members, catalysed by FAIRTRANS, has transformed climate discourses from winners and losers to a joint vision, leaving nobody behind. FAIRTRANS partners have catalysed a policy framework for green negative emissions in Swedish forestry including incentives for farmers. The EU Green Deal is focusing on achieving the >55% target 2030 and puts more emphasis to control rebound effects. Powerful CSO alliances of FAIRTRANS shapes the national climate policy arena, when politicians enjoy enhanced public acceptance to the transformations needed. By then a widespread societal hope in reaching the Paris accord emerges in Sweden (see more in table 2, in section 7).

4. Organisation of the programme

4.1 Programme management, Leadership and Organization

Stockholm University is the host of the programme. FAIRTRANS is structured by way of five science-policy work-packages (WPs) and the programme governance and management, which we informally refer to as "WP0" because this is also important work. WP0 is coordinated by the programme directors and includes all aspects of FAIRTRANS except the WP groups (Fig. 2). The listed activities in Table 1 will be chronologically coordinated by the program directors, with roles clarified below.

Figure 2. Organisation chart FAIRTRANS.



Board (B)

The chair of the board is Ethel Forsberg. The other board members are Helen Rosengren, Per Espen Stoknes, Pernilla Bergmark, and Leo Rudberg.

The board's mission is to ensure that the FAIRTRANS is run in line with the intentions of the agreement between MISTRA and Stockholm University as well as the bilateral sub-agreements signed between participating universities and organisations respectively. The mission is also to secure participation of non-academic organizations and to give FAIRTRANS deliverables a clear role in different networks in society working with societal transformations for climate action. The board approves research directions, how to use strategic reserves, appoints international reviewers and is ultimately responsible for the annual reports and the final report. They meet several times per year using digital devices and once or twice physically. We anticipate an active board with continuous dialogue with the programme directors about strategic decisions.

The Executive group (ExG)

ExG is led by two program directors (PDs)Thomas Hahn and Stephan Barthel. The PDs are responsible for operating all daily affairs within FAIRTRANS. They are responsible for reporting to the board, for coordinating recruitment, for arranging assembly meetings with all partners in spring and autumn each year, and setting up and running activities and courses. ExG consists of the programme administrator, head of communications and selected WP leaders. One of the tasks for the WP leaders is to search for synergies between WPs, and with the head of communications to secure interest from all academic partners and partner-CSOs including firms.

Five WP Groups (WpGs)

WpGs are responsible for the scientific production and co-creation work (described in section 6). One appointed leader (two for WP5) runs each WpG and all these WpG leaders take part in all of the ExG meetings. Regular internal WpG meetings are proposed, including PhD students, supervisors and mentors from the participating organizations. In between these whole-group meetings, each research task has regular meetings.

Transformation Advisory Board (TAB; Formerly called the Policy Group in figure 2)

TAB is an informal network of CSOs involved in WP5. TAB discuss and communicate policy implications of results produced in the WpGs. It is led by a coordinator from one of the participating CSOs. One key task is to secure contact and communication with users and receivers of FAIRTRANS deliverables. TAB will approve the *Climate Transformation Manifesto* that will be one main deliverable of the proposed programme. TAB can take initiatives for outreach activities and for spreading the intentions and results of FAIRTRANS for climate action in the wider society. The TAB coordinator will also support the executive group and the board in the arrangements of the assembly meetings.

***Table 1*. Time plan activities in FAIRTRANS**

Abbreviations: ExG= Executive Group (ledningsgrupp); WpG = Work package groups; B = board; IR = International Reviewers. CT= Communication Team.

Year	
1	1) FAIRTRANS-office at Stockholm University. Establishment of organisational units: *B*; *CT, Leaders for WP1-5* and *ExG* 2) Meetings (number) in *ExG (10)*, *B* (5) 3) Recruitment postdocs and a PhD student 4) Appointment of Head of communication and administrators 5) Start-up for the recruited scholars and PhD-student 6) 'Kick-off' as the first *assembly FAIRTRANS meeting*. 7) Meetings in each of the five *WpG* are held *(10)*
2	1) Annual Report by *CT*. 2) Establishment of organisation unit: *PG and IR* 3) Programme directors meeting with each *WpG* (January – February) 4) Meetings: *ExG* (8), *B* (4), *WpG* (4), *CT (4),* *5) assembly FAIRTRANS meeting* (2). 5) Revision of plans for the *WpGs* 6) National study tour 7) Workshops, T-labs and teaching activities (swe. studiecirklar) in creating a discourse for a carbon budget based policy
3	1) Annual Report 2) International Review (IR) 3) Meetings and assembly: the same as for Year 2 *(points 3-5)* 4) Co-creation activities: workshops, T-labs and teaching activities in creating a discourse for a carbon budget based policy 5) PhLic defense/half-time PhD seminars
4	1) Final Report 2) Annual Report 3) same routines for meetings as year 2-3. 4) Co-creation activities: workshops, T-labs and study circles 5) Final national Conference

Communication Team (CT)

The head of communication will lead this group and is responsible for leading the practical work of identifying key audiences and channels to reach these audiences, in addition creating all annual reports and the final report from inputs provided by the WPs and PG. See Chapter 8.

International Reviewers (IR)

The international perspective is important to ensure that the co-creation processes make novel contributions also in an international context. Well-renowned international scholars will be engaged for a midway evaluation of the outcomes in FAIRTRANS. IR may include international researchers in the board.

5. Our skills, partners and networks

5.1 Academic partners

5.1.1 Stockholm University.

Stockholm University is one of the 200 highest-ranked universities in the world and one of the top 50 universities in Europe according to several well-established university ranking tables. Being an independent centre within the Science Academic Area, Stockholm Resilience Centre was launched in 2007, based on a large Mistra grant. It has since developed into a world-leading centre for research in sustainability science, with a particular focus on biosphere stewardship and resilience in the Anthropocene. It has institutionalized links with The Royal Swedish Academy of Sciences and has its own International Scientific Advisory Council as well as an International Advisory Board. SRC's research is based on transdisciplinary biosphere-based sustainability science with innovative methodologies and extensive collaboration across disciplines and with society at large.

5.1.2 University of Gävle.

University of Gävle (HiG) has 750 employees and 16.000 students in 60 educational programs and 300 courses. In addition to subject-specific research and postgraduate education, HiG concentrates its research on four strategic and interdisciplinary research areas 1) Urban Sustainability, 2) Intelligent industry, 3) Innovative learning and 4) health-promoting work. The postgraduate business research schools Reesbe (energy system) and Future-Proof Cities (sustainable urban development) have greatly contributed to in-depth business collaboration through the joint industrial postgraduate projects in collaboration with the business and civil society sectors.

5.1.3 KTH Royal Institute of Technology

Since its founding in 1827, KTH Royal Institute of Technology in Stockholm has grown to become one of Europe's leading technical and engineering universities, as well as a key centre of intellectual talent and innovation. KTH is Sweden's largest technical research and learning institution and home to students, researchers and faculty from around the world.

5.1.4 Uppsala University

Uppsala University is Sweden's oldest university and is ranked among the top 100 universities in the world, with more than 5000 researchers and teachers and over 40,000 students. The project participating Department of Earth Sciences, with some 200 researchers, organises several transdisciplinary research programmes, including on Natural Resources and Sustainable Development, and houses the Climate Change Leadership Node where the international Zennström Visiting Professorship is placed, focusing on, for example, the research themes 'Rapid Societal Transformation' and 'A Swedish Carbon Budget Framework'.

5.1.5 IVL Swedish Environmental Research Institute

IVL Swedish Environmental Research Institute was founded in 1966 and has 330 employees with a broad environmental profile, combining applied research and development with close collaboration between industry and the public sphere. IVL leads and participates in several Mistra programmes including Mistra Carbon Exit.

5.1.6 Lund University

Lund University is ranked among the world's top 100 universities, and the Environmental Politics Research Group at the Department of Political Science engages around 20 researchers and focuses on e.g. environmental politics and sustainability governance.

5.2. Civil Society Organisations (CSOs)

The CSOs consists of democratic popular movements organisations (PMOs) with a large number of members, as well as other CSOs. They all contribute to WP5 as important actors for co-developing policies and strategies for action. They will also be invited to seminars conducted within WP2-4. Government agencies will also participate but so far only one has accepted being mentioned in the proposal.

5.2.1 Global Utmaning ("Global Challenge") is a leading politically independent think tank in Sweden that focuses on collaboration for sustainability since 15 years. It has a network of over 90 senior advisors and 30 Future Thinkers (under the age of 33) who, with cross-sectoral experience from politics, research and business, contribute to the operations. It provides a neutral platform for actors from different societal sectors, with different political backgrounds and areas of expertise. "The Climate Agenda" (Klimatagendan) is a major collaborative initiative by Global Utmaning which embraces some of the larger CSOs - trade unions (LO, TCO, Saco - the latter to be confirmed), the consumer cooperative (KF), entrepreneurs (Företagarna) and industry (Svenskt Näringsliv). In addition, several companies are active partners, including Söderberg & Partners, Svea Green Foundation, Kamtech, Signify, White Arkitekter, Tieto, and Telge Energi.

5.2.2. Trade unions

There are about 60 trade unions in Sweden, most being members of one of the central organizations LO, TCO or Saco, who are strategic partners in Global Utmaning. **Landsorganisationen (LO)** has just over 1,430,000 members organized in 14 unions (2020), of which Kommunal (municipal employees), Metall (metal workers) and Handels (Handelsarbetare) have most members. (Johan Hall). **Tjänstemännens Centralorganisation (TCO)** organizes the salaried employees, with about 1,400,000 members in 13 unions, the largest being Union (private employees), Vision (public employees) and the Swedish Teachers' Association. (Hanna Finmo). **Svenska Akademikers Centralorganisation (Saco)** organizes just over 700,000 graduate-educated professionals, in 21 unions, the largest ones being the Swedish Union of Engineers, Akavia (lawyers, economists, etc) and SSR (social workers). (Mari Ternbo). **Union to Union** is LO, TCO and Sacos organisation for international development cooperation on e.g. democracy, fair resource distribution, reduced poverty and sustainable development. (Beatrice Jansson). **Olof Palme International Center** is the Swedish labour movement's umbrella organisation for international solidarity and advocacy, and works globally for democracy, human rights, peace and social justice. (Cajsa Unnbom).

5.2.3 Kooperativa Förbundet (KF) is a consumer cooperative economic association formed in 1899, with 31 consumer associations in Sweden, all together comprising about 3,400,000 members. (Erika Troeng).

5.2.4 Hyresgästföreningen (HGF) The tenants' association is a member-runned organization, representing tenants, having over 500,000 members. HGF is a partner to Global utmaning. (Marie Linder)

5.2.5 Naturskyddsföreningen (SSNC), Sweden's largest and oldest environmental organisation, with over 200,000 members organised in 300 regional and local groups. SSNC plays an active role in the EU and coordinates a network of CSOs in around 30 countries in the global south. (Johanna Sandahl)

5.2.6 Fossil Free Sweden is a government initiative collaborating with industries to become leaders in the transition to a fossil-free society. https://fossilfrittsverige.se/en/roadmaps. (Svante Axelsson, also Task 2.2).

5.2.7 AI Sweden is the Swedish National Center for applied Artificial Intelligence, aiming to accelerate the use of AI for the benefit of society and competitiveness. (Erik Wilson)

5.2.8 Swedish Investors for Sustainable Development (SISD) is a network for large financial actors in Sweden, including the public pension funds, the large banks and the Church of Sweden. (Suzanne Krook & Gunnela Hahn)

5.2.9 Företagarna is Sweden's largest entrepreneurial organization, representing about 60,000 entrepreneurs in different industries. The members are mainly entrepreneurs who run their own companies. (Philip Thunborg)

5.2.10 The Royal Swedish Academy of Agriculture and Forestry serves the purpose to promote agriculture and forestry and associated activities with the support of science and practical experience and in the interest of society. (Eva Pettersson)

5.2.11 Sveriges Konsumenter (The Swedish Consumers' Association) is a federation of consumer interest organisations in Sweden. They represent Swedish consumer interests on national, regional and international level. (Jan Bertoft)

5.2.11 Naturvårdsverket (The Swedish Environmental Protection Agency, SEPA) is a government agency, not a CSO. SEPA has a key role for developing and implementing Swedish climate policies and negotiating international policies. (Markus Larsson)

More Civil Society Organisations will become partners of FAIRTRANS

5.3. Research Assisting Organisations (formerly called Sub-contractors)

5.3.1. Material Economics is a management consultancy firm specialized on sustainability and resource strategy topics, aiming to help clients be successful in a sustainable society. https://materialeconomics.com/ (Peder Folke, Per Klevnäs, Tasks 2.1 and 2.2)

5.3.2 Svensk Kolinlagring is a collaborative platform that gathers farmers, researchers, businesses and other food system actors around the goal to design a system that incentivizes carbon sequestration in agriculture. https://kolinlagring.se/ (Lova Brodin, Louise Hård af Segerstad, Task 3.4).

5.3.3 Future Position X is an independent Digital Innovation Hub based in Gävle. FPX provides both technology and expertise to contribute to data-driven community solutions for decarbonized coworking arenas, digital commons and other forms of digital remote work. https://fpx.se (Per Andersson, Task 4.2)

5.3.4 The Remote Lab is a knowledge and development node focusing on the future of remote work. The vision is to assist society, organizations, and individuals in the transformation from the norm of the physical workplace to a remote mindset on both societal and organizational development. https://remotelab.io (Maria Svensson Wiklander, Task 4.2)

5.3.5 We Don't Have Time (WDHT) is a social media and review platform for climate action, with 30,000 members from 143 countries, who together have written over 2,000 climate reviews. The app is top-rated on App Store (4.7) and Google Play (5). www.wedonthavetime.org (David Olsson, Task 4.3)

5.3.6 Eco-Forestry Foundation works to spread knowledge of ecosystem-based forestry by establishing demonstration areas and supporting research initiatives showing how to design and implement sustainable and profitable forestry. https://www.ecoforestryfoundation.se/en/ (Mikael F Karlsson, Task 3.3)

5.4 Key staff

Thomas Hahn (SRC), associate professor in environmental social science (Suggested Program Co-Director). Hahn is the country representative for the European Society for Ecological Economics and he has had extensive collaboration with CSOs during his career, e.g. chair for Swedish Economists for Sustainability. He has been Coordinating Lead Author for both The Millennium Ecosystem Assessment and IPBES. He has been Director of

Studies and developed MSc programmes at SU. His research spans from institutional and ecological economics to multilevel governance and stakeholder collaborations for transforming ecosystem management.

Stephan Barthel (Gävle + SRC), professor in sustainability science (Suggested Program Co-Director). Stephan Barthel is a highly cited scholar in "web of science" (2019, 2020). He holds a PhD in natural resource management from Stockholm Resilience Centre. He is the director of a challenge driven research program on urban sustainability at the University of Gävle with the mission to stimulate the integration of socio-technical transition research with that of social-ecological systems research.

Kristina Persson (Global Utmaning) is founder and former leader of the think tank Global Utmaning and the initiator of the project "Klimatagendan". She is a former Minister for Strategic development and Nordic cooperation (2014-2016) and has been a member of the Swedish and European Parliament. She has also worked for 18 years in the trade union movement. She has a Master of Economics and Business Administration from the Stockholm School of Economics and is a trained diplomat at the Foreign Office.

Eva Alfredsson (KTH) is a policy analyst at the Swedish Agency for Growth Policy Analysis, which focuses on e.g. green transition of industry. Eva has been an expert in several parliamentary inquiries, recently in the committee developing Sweden's climate policy framework. Eva received her PhD at Umeå University in 2002, at the Environmental Spatial Modelling Centre. She is a part time researcher at KTH and her publications explore scenarios for sustainable development beyond traditional GDP-growth.

Johan Colding (Gävle/Beijer) is a highly cited researcher with over 22,000 Google Scholar citations. He works as Associate Professor in Sustainability Science at the University of Gävle where he also acts as the director for the Urban Studio. Johan is linked to the Beijer Institute of Ecological Economics where he has been a co-founder of social-ecological systems research; he also leads Beijer's urban research. His expertise encompasses institutions and property rights, resilience science, social-ecological system dynamics, digitalization, smart cities, and smart growth.

Mikael Karlsson (Uppsala) is Associate Professor in Environmental Science and PhD in Environmental and Energy Systems. In March 2021, he will begin as Associate Professor in Climate Change Leadership at Uppsala University. His research focuses on environmental governance and science-policy interactions linked to e.g. science denial and climate policy. He has served for over 20 years in expert and research bodies in Sweden and the EU and is board member of e.g. the Swedish Forest Agency and of the Commission's High Level Group on Energy Intensive Industries. He was President of the Swedish Society for Nature Conservation (2002-14), and of the European Environmental Bureau (2005-17), Sweden's and Europe's largest environmental organisations.

Ingo Fetzer (SRC) is researcher at Stockholm Resilience Centre and the Bolin Center for Climate Research. He has expertise in structural and spatial explicit modelling investigating dynamic whole system processes. Fetzer was participating in conducting model feedback analysis for IPCC report models. As co-leader of the EU ERC project 'Earth Resilience in the Anthropocene' he is leading analyst for estimating planetary boundaries.

Sarah Cornell (SRC), Associate Professor in Sustainability Science and a principal researcher at SRC, brings expertise in global change, social-environmental systems, and integrative sustainability research, engaging in transdisciplinary dialogues with policy, private sector and communities at all levels. Current research includes circular economy and the economics of planetary boundaries. She was a lead author of the Arctic Resilience Report (2013, 2016), expert reviewer for IPCC WGII and contributing author to Chapter 1 in IPCC AR5.

Roger Hildingsson (Lund) is PhD in political science and researcher in environmental politics and climate governance at Lund university. His current research focuses on climate governance, decarbonization politics and

the transition towards post-fossil futures, empirically focusing on a multitude of sites at which environmental governance is shaped and takes place.

Laura Pereira (SRC), DPhil in Geography from the University of Oxford, is a specialist on sustainability transformations and futures in the Global South. She is currently the co-PI of the CCAFS scenarios project. Laura sits on the IPBES Task Force on scenarios and models and the FACCE-JPI Scientific Advisory Board.

David Collste (SRC) is a Marie Curie PhD-candidate in sustainability science (SRC) and economics (University of Clermont Auvergne). He holds a licentiate degree in sustainability science. His research focuses on implementing the 2030 Agenda and will be part-time postdoc for FAIRTRANS.

Mathias Cehlin (Gävle) is Associate Professor in Energy Systems at University of Gävle. Mathias Cehlin is a driven researcher in energy systems, appointed co-director of the strategic research area Urban Sustainability at the University of Gävle. Mathias also co-ordinates the research program Urban Transition with a mission to accelerate the transition to a sustainable society through changes in technical, ecological and socio-technical systems.

Marita Wallhagen (Gävle) is Associate Professor in Environmental Science at the University of Gävle with a PhD from KTH. She is Co-Director for the research program Urban Transition, with the mission to accelerate the transition to a sustainable society.

Stefan Sjöberg (Gävle) is an associate Professor in Social Work and Senior Lecturer in Sociology at University of Gävle. His research focuses on community work in vulnerable neighborhoods and urban commons for socially sustainable development.

Patrik Sörqvist (Gävle) works as Professor in Environmental Psychology at the University of Gävle where he also acts as the Head of Department of Business and Economic Studies. His primary research interests centers on the psychology and behavior of human-environment interaction.

Mikael Malmaeus (IVL) is associate professor in Environmental Analysis and works transdisciplinary in sustainability issues, including policy instruments, EIA, cost-benefit analysis and macroeconomics. Current research includes scenario development beyond GDP growth, rebound effects and design of policy instruments.

6. Work packages (WP)

The organization of the FAIRTRANS WPs (see Figure 1) is inspired by Raworth's "Doughnut" symbolizing an environmental 'ceiling' and a social 'floor' (cf. Raworth 2017). It is meant to direct attention to how FAIRTRANS is designed in relation to a fair transformation to a fossil free future (see figure 1). The foundational research work-packages WP1, WP2 and WP3 clarify what a fair transformation to a fossil-free society means for the use of Sweden's remaining fossil carbon budget as well as for its economy. WP4 and WP 5 are about the climate action needed for this societal transformation. The organization of these WPs attempts to co-create a fair future while achieving the Paris agreement. WP0 is the governance and management of FAIRTRANS. The impact logic of the program is illustrated in figure 3.

6.1 WP1. A fair science-based carbon budget for Sweden

WP1 is led by PhD Ingo Fetzer. The work is also based on expertise of Associate Prof. Thomas Hahn, Associate Prof. Sarah Cornell, postdoc David Collste, and Associate Prof Mikael Karlsson.

6.1.1 Background and relevance to call:

Mitigating carbon emissions, halting biodiversity loss and preserving other essential ecosystem services are central goals of 'green deals', but real action demands better knowledge of the interdependencies of these goals. National carbon budgets have been assessed for Sweden's energy system (Anderson et al. 2014), and Fauré et al. (2019) showed four developments beyond GDP growth that could reduce Sweden's emissions from food and other consumption in line with keeping global warming within 1.5 °C with 50% likelihood. However, we still miss a national carbon budget based on an Earth system science understanding of climate and biosphere interactions that also applies transparent fairness principles. Any such assessment of a carbon budget that meets global climate goals is very sensitive to assumptions about biosphere responses and capacity to recover from 'overshoots' (Smith et al. 2016). A transdisciplinary Earth system science endeavour understands the structure and functioning of the Earth as a complex adaptive system. From an Earth System view, national carbon budgets should be analyzed with global climate and biosphere connectivities, e.g. through the hydrological cycle and altered biogeochemical cycles (Wang-Erlandsson et al. 2018, Mezzina et al. 2020). Taking macro scale biophysical dynamics into account is a vital step in developing an integrated approach to production-based (territorial) and consumption-based budget assessments. It also helps to track climate risks that are 'exported' from, rather than mitigated in, Sweden. It is vital to consider Sweden's emissions from this global socioeconomic perspective. Social telecouplings (Lui et al. 2013) illuminate that vulnerabilities of climate change impacts are often greater in the Global South (Adger et al. 2009, Moser & Hart 2015). Through globalization, new types of telecouplings are becoming evident, creating environmental stresses and resource depletion far from drivers (Lenschow et al. 2015, 2016). Moreover, carbon budgets and societal pathways are influenced by different fairness principles, reflecting different values and understandings of global and national responsibility for action (Häyhä 2016; 2018).

6.1.2 Aim and research questions

The Paris Agreement was adopted more than five years ago but gaps in relation to achieving the accord are well known. The aim of WP1 is to model various scenarios for Sweden and assess their contributions to achieving the Paris target. WP1 provides a comprehensive foundational building block for FAIRTRANS, consisting of assessment of the national carbon budget for Sweden under different biophysical assumptions and allocation principles, and assessment of fair goal-effective pathways for achieving a fossil free Sweden over time. The WP will answer the following questions:

1. What is the Earth-system informed fair national carbon budget for Sweden (task 1.1);
2. What are the key gaps compared to the present situation and what pathways may bridge them? (task 1.2);
3. What trade-offs and synergies may emerge with the pathways for achieving the Paris Agreement? (task 1.3)

6.1.3 Tasks, methods and outputs

Task 1.1 Earth system-informed national carbon budgets

This task will place the global carbon budget within a larger Earth system science framework and provide a review of implications of the Paris Agreement fossil carbon budgets for Sweden. It will evaluate how global climate trajectories and national budgets are contingent on assumptions on complex ecosystem carbon exchange (atmosphere, terrestrial and ocean and feedbacks among them), negative emission technologies (CCS, BECCS, DAC, etc.), and alternative international fairness principles (e.g. immediate or cumulative per capita, rights- or efficiency-based). **Methods:** We will analyze cross-scale effects in historical development and future Representative Concentration Pathways (RCP) data sets provided by the Inter-sectoral impact model

intercomparison project (www.isimip.org). Assessment of land use patterns, sector impacts and the amount of biosphere-reliant 'overshoot' will be done with global data from 32 climate models to better capture the dynamics of Earth's climate and biosphere interactions and to account for model uncertainty.

Outputs: A transparent set of national carbon budget assessments that take the biophysical effects of alternative NETs and fairness principles into account will be compiled as a basis for this and other WPs.

Task 1.2. National pathway development and gap analysis

Achieving the Paris Agreement while simultaneously meeting SDGs requires translating carbon budgets to pathways that meet various targets for 2030, and on intermediate (2050) and long-term (2100 and beyond). However, even if the national carbon budget from task 1.1 meets these requirements, critical knowledge gaps exist on, for example, i) the need for emission cuts in different sectors, ii) effects of cross-sector interactions, , and iii) economic investments at national, international and inter-generational levels. To fill these knowledge gaps, a national pathway that supports SDG-goals as well as considers sectoral and economic aspects will be developed, in relation to an assessment of the shortcomings of a 'business as usual' scenario. This will allow the costs of inaction to be assessed and the emission reduction gap to be tracked over time. **Methods:** Advanced integrated assessment models (e.g. global models GLOBIOM, MAgPIE and the European regional model CAPRI) will be used to create geospatially-explicit, quantitative pathways for future outcomes on various aspects of agriculture, land use change, technological changes and key sectors. Globally embedded national models will be used to estimate how national scenarios play out locally and also how national goals affect environmental footprints on other countries. On the latter point, assessments will be made of Sweden's global footprint for carbon emissions, water use, and biodiversity, including analysis of different decisions on e.g. consumption, production taxes on GHG emissions, taxes reflecting GHG contents of commodities, technical mitigation, and NETs.

Outputs: This task provides quantitative assessments for a transformation pathway that considers the efforts in various sectors in Sweden. It also evaluates the implications for SDG achievement while remaining within the national carbon budget. Outcomes will directly feed into all work packages.

Task 1.3. Pathway consequence analysis

The purpose of this task is to examine socioeconomic and ecological trade-offs, synergies and spillovers. Some of these are evident in the quantitative pathways from Task 1.2. Others are known to be important but require bringing in additional aspects that are not well captured in Earth system and integrated assessment model frameworks, notably the governance and human capabilities aspects that are vital for transformation. This consequence analysis will also allow reiterative evaluation of stakeholder-proposed strategies. **Methods:** A mix of quantitative and qualitative methods will be used to support 'translation' between the model-based pathway assessments and well-evidenced narratives that capture the full range of SDGs. It will follow emerging best practice through expert deliberations with international research projects using scenario approaches (The World in 2050 and the JPI-Climate SHAPE project). Moreover, a qualitative ethical analysis will be done of various interpretations of fairness, and its meaning for carbon budgets.

Outputs: Richer-picture carbon reduction pathway-scenarios that illustrate the range of cross-scale social-ecological consequences of Earth system insights and transparent allocation principles. One paper on fairness and carbon budgets. The outcomes of this task will inform the WPs involved in stakeholder co-creation.

6.2 WP2. Budgeting fair transformations

WP2 is led by Dr. Eva Alfredsson. The work is also based on expertises of Associate Prof. Thomas Hahn, Associate Prof. Mikael Malmaeus, Associate Prof Mikael Karlsson, Associate Prof. Sarah Cornell, postdoc David Collste, subcontractor Material Economics and the coordinator for Fossil-Free Sweden, Svante Axelsson.

6.2.1 Background and relevance to the call

The science base for transformative change is strong. EASAC – the European Academies' Science Advisory Council recently addressed the need for transformative change. An increasing number of studies provide solid evidence that there are substantial economic benefits of climate action in the short as well as long term. Updating the models with the latest data on climate sensitivity etc. show that the economically "optimal" abatement could very well be in line with the Paris Agreement (Glanemann et al. 2020). Meanwhile, the unsustainable trends have not yet been changed. One of the main conclusions in the EASAC report (2020) is that the needed transformative changes challenge the social and political paradigm of at least the past 70 years. Barriers of change are powerful vested interests, elite groups, the limited capacity of governments to plan and implement policies with timescales of decades that straddle multiple electoral cycles and lack of public understanding and a resistance to change. While reduced consumption through circular economic models and the sharing economy will play a role, the coronavirus pandemic has clearly shown limits to achieving net zero emissions through reduced economic activity. In order to reach the climate goals we need investing in new ways of production and consumption. The global investments required for a Paris-compatible pathway has been estimated to be USD 1.4 trillion per year in the period 2020-2024, which is still a modest sum compared to the global stimulus funds.

6.2.2 Aim and RQ

WP2 aims at identifying technological investments that accelerate emission reductions within the carbon budget. We also analyse how the efficiency gain relates to decoupling and rebound effects. Finally, we analyse the effects on rapid decarbonisation on the SDGs. Three research questions are explored:

1. How should technological innovation and investments be steered to achieve a transformation of the Swedish economy within the carbon budget? (Task 2.1, 2.2 and 2.3.)
2. Acknowledging the importance of rebound effects on the rate of decarbonisation, how can ideas of social progress be "decoupled" from the GDP growth paradigm? (Task 2.4)
3. How are the costs and benefits of these measures distributed within the Swedish population and among economic actors in the short and long term and its effects on Swedish SDG achievements? (Task 2.5.)

6.2.3 Tasks, methods and outputs

Task 2.1.Calculations for technical transitions for Swedish sectors

Our previous research suggests that existing technical transitions in industry and transportation fall short in achieving the Paris Agreement, but the technical potential is high for a rapid decarbonisation if policies and investments are coordinated across sectors and massive investments in solar and wind power is substituted for bioenergy (Material Economics 2021). We identify the potential of technologies and innovations to achieve net zero emissions, and analyse what investments in joint infrastructure (e.g. electricity, hydrogen) are needed to avoid overusing scarce resources (e.g. biomass).

Method: The technical measures are identified through a literature review and interviews with stakeholders across various industries. The literature includes roadmaps developed by various Swedish organisations, the Swedish government's Climate action plan, and Swedish and international research papers. Each measure is

then quantified and analysed in terms of emission reduction potential and feasibility of implementation, across sectors.

Output: A holistic technical 2045 scenario for Swedish decarbonization, which is integrated across sectors. This serves as an analytic base for other parts of the WP and in other WPs.

Task 2.2. **Investments in sustainable infrastructure: linking carbon and economic budgets**

Real capital investments are key for sustainable transformations. At the same time, investments often have negative environmental effects. Investments cause approximately twice as much carbon dioxide as consumption and production in general (Alfredsson & Malmaeus 2019). The carbon dioxide budget calculated in WP1 thus limits how much can be invested and necessitates a significant "carbon return on investment"(CROI), a novel concept introduced in this research. In parallel, investments must provide a basis for a more resilient economy and welfare, including the seldom addressed distributional effects. Hypothetically, high early investment levels cut emissions fastest but each investment needs to be analysed carefully in order to avoid high short term carbon emissions and unsustainable resource use. In this task we create a policy framework for how to prioritise between different investments in order to best promote the foreseen transformation.

Method: The task first expands previous analysis (Alfredsson and Malmaeus 2019) of the carbon return on investments by adding recent data through a literature review. We then analyse and calculate carbon return on key investments. In the next step we develop a framework for prioritising investments based on criterias (CROI, cash- and CO2-emission flows over time, short term and long term resource requirements, the marginal utility of investments and from a distributional perspective, co-benefits of investments beyond climate benefits etc.). The criteria are discussed with stakeholder groups in workshops in order to estimate weights. Using the results and roadmaps in task 2.1 and 2.2 we develop scenarios for investments within the remaining carbon budget and illustrate different distributional effects in terms of costs and benefits.

Output: A science-based but also co-created strategy for investments within the carbon budget, optimising positive effects on economic development and well-being. 1-2 scientific articles, 2 workshops and one popular science article.

Task 2.3 A cross cutting analysis of the roadmaps developed within "Fossil Free Sweden"

Based on the carbon budget frame from WP1 and the outcome from task 2.1 and the policy framework developed in task 2.2, we will in this task analyse the sector-wise so-called "roadmaps" for phasing out fossil fuels, developed by business stakeholders under the facilitation of the Swedish government's initiative "Fossil Free Sweden". Four of the 22 roadmaps that so far have been adopted (preliminary within the industry, building, traffic and energy sectors) will be analysed in-depth, with respect to investment needs, potential trade-offs, obstacles and synergies within and between the roadmaps. The aim is to provide practical guidance on how the roadmaps can be implemented and test the policy framework developed under 2.2. The results will directly feed into WP5.

Method: Together with actors within Fossil-free Sweden, we will analyse individual roadmaps and synthesise available roadmaps to understand how these roadmaps shape and are shaped by biosphere feedback and how they relate to carbon return on investments.

Output: One scientific publication and one popular science publication oriented to the industries and policymakers.

Task 2.4. **Green growth, decoupling and post-growth**

In this task we critically and constructively analyse the EU green deal from a short and long term perspective. The EU Commission presents its Green Deal as "a new growth strategy that will transform the Union into a modern, resource-efficient and competitive economy, where there are no net emissions of greenhouse gases by 2050, economic growth is decoupled from resource use, and no person and no place is left behind." We agree that one challenge is to catalyse technological development and innovations to maximise decoupling, understood as the difference in rate of change between GDP and CO2 emissions. However, rapid decarbonisation also requires that we control rebound effects. Global decadal average decoupling have historically never exceeded 2.7% (Holz et al. 2018) and the most optimistic scenarios for decoupling may be 4 percent annually, assuming aggressive possible abatement policies (Hickel & Kallis 2020). In the EU, GDP has lately (2014—2019) increased by about 2% annually. This jeopardises the absolute emission cuts needed to meet the Paris goals significantly (Fig. 3 below).

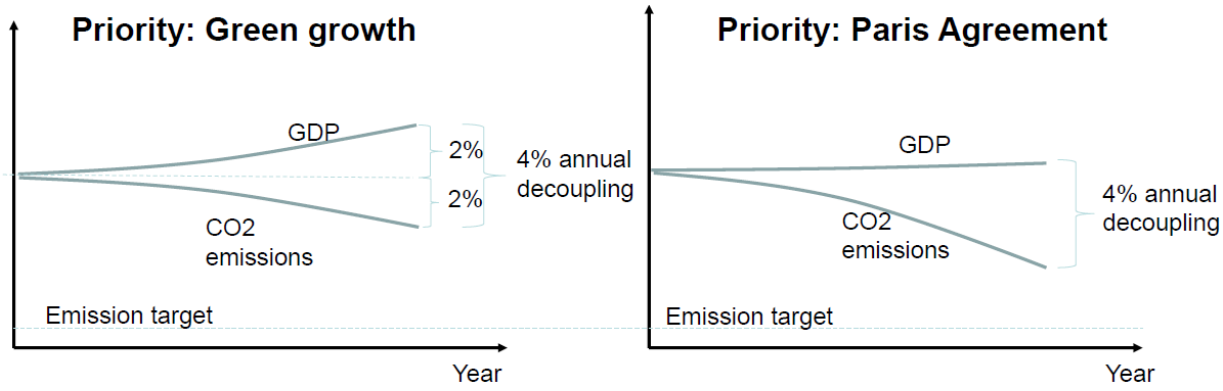


Fig. 3. Two scenarios given the same policy tools for achieving decoupling. The difference is that rebound effects are controlled when emission reductions are prioritised.

The European Environment Agency has recently addressed our Research Question: "Could the European Green Deal, for example, become a catalyst for EU citizens to create a society that consumes less and grows in other than material dimensions?" (EEA 2021). In this task we explore decarbonisation trajectories which are not contingent on GDP growth. Our approach is thus "a-growth" or post-growth rather than degrowth (Van den Bergh & Kallis 2012, Parrique et al. 2019) and we hypothesise this approach is relevant to high-income countries.

Method: We first start with a review of the literature of green growth, decoupling and rebound effects. Second, based on the literature review and the findings in Tasks 2.2 and 2.3, we will develop scenarios following IPBES ECA (2018) which go beyond the green/sustainable growth paradigm, which we regard as an adaptation within the GDP growth regime, not a real transformation. Third, we conduct a discourse analysis (Gee 2014) on the paradigm of green growth and decoupling, which seem to constrain not only policy development but also the policy discourse. We will develop alternative discourses, which can feed into the policy development in WP5.

Output: A literature review on decarbonisation focusing on controlling rebound effects, resulting in scenario developments (Paper 1) which will feed into WP5, and a discourse analysis (Paper 2) which we hope will promote new discourses beyond the green growth and decoupling narrative.

Task 2.5 Modeling society-wide impacts of interventions

In close collaboration with task 1.3 this task applies a system-wide simulation model for national development that incorporates targets on all 17 SDGs, the iSDG model. iSDG is a system dynamics-based model developed by the Millennium Institute (Millennium Institute 2017) that is uniquely suited for analysis of anticipated future SDG achievements, including socio-economic, governance and ecological dynamics for policy coherence (Collste

et al. 2017). The model incorporates economic sub-sectors (including agriculture, industry and services sector), social sub-sectors (including e.g. health, education and employment outcomes) and environmental sub-sectors (including, e.g., land use, soil quality, emissions). The model simulates anticipated development over 10 to 30 years into the future. It has been applied to various countries (Pedercini et al. 2020, Allen et al. 2019). The model is designed to assist policy planning and stakeholder interactions by providing a credible representation of real-world development and modelling effects of policy choices such as investments in different sectors. All relationships in the model are visually illustrated by causal links and loops making it accessible to non-modelers. Stakeholders can suggest alternative model formulations to compare scenarios, providing opportunities to discuss long-term implications of decisions made today. One scientific paper will be produced.

6.2.4 Expected impacts (near and future)

The outcomes of WP2 will contribute to a better policy discussion among both experts and lay persons and feed directly into all other WPs. Large CSOs and the informed public will better understand how carbon budgets and rate of emission reductions are influenced not only by technology but also by rebound effects. The effects of industrial investments on climate, bioenergy and the wider biosphere will be better understood, as well as effects on distribution and Sweden's ability to achieve all SDGs.

6.3 WP3. Green negative emission technologies to accelerate decarbonisation

WP3 is led by Associate Prof. Thomas Hahn. The work is also based on expertises of Associate Prof. Mikael Karlsson, Associate Prof. Ingo Fetzer, Associate Prof. Sarah Cornell, a postdoc, a PhD student, and subcontractor Svensk Kolinlagring.

6.3.1 Background/relevance to call

Although the title of this programme focuses on “fossil-free futures” we believe it’s important to also address the green carbon. Today Swedish forests are a huge net carbon sink of 38 Mtons of CO2e while agriculture is a large net carbon source of 7.5 Mtons of CO2e, of which 3,5 is animal husbandry, 3.5 soil leakage and 0.5 fossil fuels (SEPA 2019). Among all negative emission technologies (NETs) considered by the IPCC one concerns forestry (afforestation/reforestation) and one concerns modifying agricultural practices. Whereas the former is already under operation, e.g. a net increase in European forest carbon stock of 0.76 GtC/year, soil organic carbon (SOC) in agriculture has an unrealised global potential of similar magnitude, if limited to the top-soil level (EASAC 2018). Green NETs have a significant role, up to 5%, for achieving EU:s new target (Dec 2020) to reduce CO2 emissions by 55% in 2030. Swedish forests have for the last century been a huge carbon sink thanks to increasing standing volume, hence densification rather than afforestation/reforestation. Sweden has 28 Mha forest land, with the FAO definition, of which 23.6 Mha are called “productive”, i.e. with an annual tree growth of >1 m^3/year. 1.4 Mha are legally protected and excluded from the analysis. The remaining 22.2 Mha have a standing volume of wood of 3,116 Mm^3, which is equal to 2,867 Mt CO2 (781 MtC). The total standing volume has increased 55% since 1950. This is because only 75% of the annual wood growth of 115 Mm^3/year is harvested or lost. This accumulation of wood provides a net carbon sink of 38 Mtons CO2/year (in this figure reported to UNFCCC all forest land is included) which is equivalent to 75% of Sweden’s total territorial emissions of 51 Mtons CO2/year. The carbon benefits of increasing standing volume is thus several times larger than the climate benefits following substitution effects (SEPA 2019). How to optimise these strategies is analysed in Task 3.1. Substitution effects of active forestry occur when wood is captured in long-term uses like constructions so that its carbon is kept out of the atmosphere for long periods and this timber replaces carbon-intensive materials such as steel or concrete. However, the substitution effects are less for bioenergy according to some actors who

emphasise that “the use of wood in bioenergy releases its carbon to the atmosphere very swiftly” (EASAC 2017). Indeed, about 80% of harvested volume Bioenergy mainly consists of residuals from sawing mills and paper and pulp industries and the bioenergy quantities in Sweden are large in a European perspective. Bioenergy contributes to the Swedish fossil-free electricity and central heating system but the substitution effects are debated. The conflicting perspectives and demand on bioenergy are addressed in Task 3.2.

Forests must be resilient to generate any climate benefits (Lindroth et al. 2009). There was hardly any increase in the standing volume of Swedish forests in 2005, when the storm Gudrun hit Southern Sweden (SLU 2017). The drought in 2018 also closed the gap between total tree growth and total drain from harvests and losses. Other European countries have adopted policies to climate change but Sweden is lagging behind (Andersson et al. 2018). Continuous Cover Forestry (CFC) and other adaptations to sustainable forest management (SFM) are assessed in Task 3.3.

Agricultural production uses fossil fuels directly and indirectly and land use causes even more greenhouse gas emissions. Climate-related societal transformations need to engage several actors to realise potential co-benefits from regenerative agriculture that builds back soils and sequesters carbon dioxide from the atmosphere. Increasing SOC has several co-benefits in degraded soils, including improved structural stability and agricultural productivity. The IPCC points out carbon farming as a cost efficient and necessary way to keep global warming under 1.5 degree (Task 3.4).

6.3.2 Aim and RQ

The aim of WP3 is to explore avenues to make Swedish forestry and agriculture sustainable carbon sinks and reconcile conflicts on how to optimise these green climate benefits. Our research questions are:

1. Acknowledging the potential for climate benefits from both standing forests and forestry, how can these climate benefits be optimised in a legitimate and cost-effective way?
2. Looking specifically at bioenergy, how can the present conflicts be resolved?
3. How can Swedish forests increase their resilience to various stresses and shocks in order to safeguard its climate benefits?
4. How can innovation for carbon farming and regenerative agriculture be catalyzed in collaborative ways with diverse stakeholders?

6.3.3 Tasks, methods and outputs

Task 3.1. Economic and carbon analysis of forests as carbon sink and substitution effects of forestry

We start with a literature review of the climate benefits of standing forests and forestry. The two main hypotheses, mentioned above, concern the potential of different strategies: increase standing volume and soil carbon in existing forests vs. increase harvests to maximise substitution effects of forest products. In this literature review we also include soil carbon, where 59% of carbon is stored, compared to 41% in biomass (SLU 2017). Under the LULUCF Regulation, EU Member States must calculate and control greenhouse gas emissions from land use, land use change and forestry. LULUCF for Sweden has been calculated to -44 MtCO2e/year (MoE 2019). This includes not only forests as sinks but also substitution effects. By proposing a national Forest Reference Level (FRL) for the period 2021-2025 which is much lower, -30 Mt CO2e, the Swedish government has ensured some flexibility, i.e. options to increase harvest rates. Based on the literature review, and diverging policy initiatives and proposals by different stakeholders regarding LULUCF, we develop different scenarios for how to optimise climate benefits from Swedish forests and forestry. “Optimising” in this context of uncertainty is understood as output legitimacy (Vatn et al. 2017) in terms of reducing uncertainties and achieving climate benefits in a cost-effective way. These scenarios will feed into Tasks 3.2 and 3.3. 1 sc. paper.

Task 3.2 Reconciling bioenergy conflicts with a civil society focus

Bioenergy is central in scenarios for achieving climate targets, but a polarised debate has caused political reluctance and conflicting policies, even when the science is clear. It is critical to explore the reasons for this situation and promote science-based reconciliation; are for example epistemological or normative issues at play? The aims are to i) produce knowledge about the reasons for diverging views on bioenergy, and to ii) identify and seek to build support around potential common science-policy denominators. The latter will be helpful for co-creating transformative policies. More precisely, two questions are in focus:

1. Which are the reasons for conflicting views on bioenergy in Sweden and the EU? Do opinions differ due to contradictory understanding among actors of the scientific underpinnings, due to conflicting values, or both? Which factual and policy-related claims and proposals do various actors advocate and why?
2. Which are the most important common science-policy denominators on sustainable bioenergy among key actors in Sweden and the EU? Which normative, epistemological and policy-related factors may impede or help a common view? Can disagreements be reconciled by closure or consensus-seeking?

Method: We will first study stakeholders' views through a review of reports from various organisations, searching for values, assumptions, arguments, framings and proposals, and the understanding of science-policy interactions, including science denial, uncertainty, governance. This will be complemented with semi-structured interviews with civil society, agencies and businesses in Sweden and the EU. Networks and previous research among the researchers (Karlsson & Gilek 2019, Edvardsson Björnberg et al. 2017, Karlsson 2005) provide a basis for the work. Next, a series of roundtables will be arranged in order to identify the largest common denominators among key actors in Sweden and the EU. Reasons for disagreements and shared views will be explored, and approaches for reaching closure or consensus will be made. Theoretical, methodological and practical experiences from previous research (and Bulkeley & Mol 2003. Sandström et al. 2013) will be applied. The researchers' networks will ensure broad participation. Delphi consensus exercises will be considered for identifying common views (Adler & Ziglio 1996). Studies have shown a potential of this method to identify experts' consensus on complex issues (Guglyuvatyy & Stoianoff 2015, Fischer et al. 2014). In addition to the aim, the task as such may promote improved dialogue in general among participants.

Output: Two peer-reviewed articles will be written (e.g. 'Bioenergy Controversies: the interplay of science and norms'; 'From Conflict to Closure on Bioenergy: the Largest Common Denominators'). This will feed into the thesis mainly based on task 5.1. Two op-eds will be written (Sweden and EU). Reports from e.g. roundtables.

Task 3.3. Safeguarding the resilience of climate benefits.

Only resilient forests with high ecosystem insurance value can function as carbon storage; less resilient forest stands, like spruce monocultures, are increasingly vulnerable to various shocks (storms, fires, insects) and stresses (drought) (Hahn et al. in review). Different forest management systems have potential to enhance direct climate benefits and also safeguard this benefit with higher resilience (EASAC 2017). Changes in soil carbon must be included when assessing climate benefits of different management systems. Boreal forest soils store 154 tonC/ha on average (Pan et al. 2011) but Swedish production forest soils only store 82 tonC/ha, higher in Southern Sweden and lower in Northern. Mires and peatland store more, 120 tonC/ha in the top 50 cm but if drained they become huge carbon sources (SLU 2017). Methods for estimation differ and make comparisons difficult but we hypothesise that there is great potential to increase soil carbon in Swedish forests by restoring mires and peatland and that continuous cover forestry (CCF) sequester more soil carbon than clear-cutting management (Clemmensen et al. 2013, Lindroth et al. 2018). German state-owned forests have been gradually converted from spruce-dominated clear-cutting management to a combination of mixed tree species and CCF systems since the 1980s, in order to enrich the structure, improve recreation value, and increase general

resilience to several stresses and disturbances (Fichtenrichtlinie, 2009). The German Federal nature protection law only allows very small (1-2 hectares) clear-cuts and forest state laws explicitly prohibit any reduction in the forest resilience against storms (Foerst et al. 2018).

Methods: First, we make a comparative analysis of the Swedish forest policies and management practices with the German, in particular state-owned forestry. We compare tree compositions and growth, standing volume and economic accounts in German (Bavarian or Lübeck) forestry with data from Southern Sweden. We also interview government officials and foresters and compare the institutional arrangement and markets. Together with the CSO Ecoforestry Foundation, we make alternative CCF scenarios, or roadmaps, for Swedish forestry to safeguard climate benefits despite stresses and shocks, where CCF is ecologically and economically appropriate. These scenarios will be discussed and modified in a workshop together with interested forest owners in Sweden and the Forest Agency. Finally, we will use the CAPRI model of Task 1.2 to assess the robustness/resilience of pathway scenarios for three or four explicit forest management strategies.

Outputs: Two peer-reviewed articles. 1-2 workshop with forest owners and Forest Agency. Two op-eds.

Task 3.4. Digital platform for incentivising carbon farming

To reach the 1.5 C target also agriculture needs to transform. The agriculture system is a part of the green carbon flow (photosynthesis and respiration), but adds fossil carbon due to extensive energy dependence. To transform agriculture many societal actors need to collaborate and experiment towards a regenerative functioning. The collaboration with innovative farmers, researchers, food companies, advisors, policy makers and other key actors within the food system that Svensk Kolinlagring constitutes, will contribute as an experiment of potential future agricultural systems. Svensk Kolinlagring have already 14 pilots on Swedish farms and together with investors interested in green NETs (including Max Burgers and Oatly) a digital platform to incentivize different management practices for regenerative and sustainable agriculture will be developed. Hence, this is a business case for trading scientifically verified negative emissions, with the aim to explore avenues for making Swedish agriculture a net carbon sink. Based on verified impacts there will be a certification scheme for investors and consumers who want to support a transformation for climate action and sustainable agriculture.

Methods: Specifically, we will expand the work on capacity building, knowledge co-production and the development of a digital platform to connect companies/investors with farmers who engage in farm practices which increase soil organic carbon:

1. The core activity is to put the knowledge gained in the pilots into practice by developing a solid business model and organization, ready to take on the task to manage and scale the digital platform. We will develop key metrics, systemic opportunities and challenges, operations, pricing strategies and financing models that are perceived as fair and predictable to farmers and investors.
2. Capacity building to scale out: as the digital platform is developing, we extend the collaboration organically to farmers with a documented interest in sustainable agriculture. Concerning input legitimacy, we are inspired by insights from research on REDD+, to move away from measuring, reporting, verification (MRV) of forest carbon to community mapping, measuring, monitoring (McCall et al. 2016). This would contribute to learning for the individual farmers and lower transaction costs for the verification scheme.

Outputs: Major impact is the realized business case for carbon positive farming, with benefits to other planetary boundaries. This will be developed through a digital platform that connects farmers with impact investors, workshops with farmers and others, and a report in Swedish and English (besides a scientific paper) on measurable NETs with a potential for making Swedish agriculture a net carbon sink .

6.3.4 Expected impacts (near and future)

Swedish forests have provided a huge carbon sink in the last decades and our results will help clarify apparent tradeoffs. We will contribute to the urgent policy goal to find a good balance between the climate benefits of increasing standing volume and the climate benefits of using wood products, including bioenergy, for substitution. Our results will explore the scope for increasing total climate benefits and also making forests more resilient to various shocks and stresses. The impacts will take decades to materialise and vulnerability may even increase during the transformation to mixed-species forests or CCF (Gardiner et al. 2013). So far there exists no economic incentives or even institutional frameworks for increasing SOC in Swedish or European agriculture. Markets exist but it is cheaper to buy negative emissions internationally. We will change this and offer the first digital platform for trading green negative emissions in European agriculture (see more in table 3, in section 7).

6.4 WP4. Fair Digital Transformation and Co-creation for Socially Accepted Climate Action

WP4 is led by Associate Prof Johan Colding (HiG). The work will be based on expertises of Prof. Stephan Barthel (SRC-HiG), Owen Gaffney (SRC), Associate Prof. Robert Ljung (HiG), Associate Prof. Marita Wallhagen (HiG), Associate Prof. Stefan Sjöberg (HiG), Prof. Patrik Sörqvist (HiG), Associate Prof. Mathias Cehlin (HiG), PhD Laura Pareira (SRC), Maria Svensson Wiklander (The Remote Lab) Per Andersson (FPX), David Olsson (WDHT), and Erik Wilson (AI SWEDEN).

6.4.1 Background and relevance to the call

The Covid-19 pandemic has clearly demonstrated the benefits of remote work via 'Zoom' and 'Teams'. Yet, not all people have access to the benefits of ICT. An ICT dependent society entails numerous risks and wicked problems (Colding et al. 2019). Vulnerable groups like elderly people, new arrivals, cognitive disabled individuals risk being excluded. As smartphones are performing an increasing amount of functions in society, a greater consideration of who's on board and who's left out needs to be taken. Moreover, as electricity is the ultimate driver of the digital society, digitalization can make our societies more vulnerable to climate-change related disturbances like storms and flooding (Sterbenz et al. 2010). Digitalization that involves an interconnection of systems and data also presents an entirely new set of security and risk management challenges (Colding et al. 2019). Hence, heightened attention to risks and social vulnerabilities is critical to account for in the digital transformation towards a new climate discourse Sweden**.** The contribution of ICT to a fair and fossil free society is, however, an overall asset. Sophisticated personal devices are important sources of sensory data and crowdsourcing, and can facilitate participatory governance, in which citizens can influence decisions on e.g. local environment. Currently, the creation of "smart cities" (Batty 2012) are promoted as a way to build more sustainable communities through integrating ICT and Internet of things technology. With the use of sensors integrated with real-time monitoring systems, data can be collected from citizens and devices, to be used for a variety of purposes, including research and improved living conditions. The digital streamlining of processes influences entire cities' metabolism, i.e. flows within and to and from a city, can be managed more optimally. Intelligent control of energy, water, sewage, waste, transport, can reduce resource consumption. Smart and automated building heating, cooling, ventilation and lighting control systems are already gaining ground, e.g. based on motion and light sensors. It is possible for people to integrate their personal calendars into the system in order to adjust to their specific schedules. While handling Big Data involves numerous ethical challenges (e.g. storage, security and privacy), it also provides a real potential to promote knowledge about attitudes, human agency, democracy and participation in the development and governance of societies.

Considering these options, behavioural changes among humans cannot solely come about through climate-change facts because many perceived risks tend rather to be socially constructed and value driven (Hulme 2020). Climate action could therefore gain from being guided by attitudes of residents, and by different meta-narratives, i.e., culturally embedded narratives of historical meaning, experience, or knowledge that embody people's beliefs about the past, present, and future. Such attitudes and narratives are plentiful and diverse, as reflected in the number of ways that local communities and CSOs perceive the world and interact with their local

environments (Colding et al. 2020). Hence, while the digitalization discourse often focuses on automation in industry and workplace (Gungor & Hanke (2009) or self-driving vehicles (Karsniqi &Kajrinzi 2016), FAIRTRANS focuses on behavioural changes which concern attitudes which need deliberation within civil society.

6.4.2 Aims and research questions

WP4 aims to promote transformation to a fair and fossil free society by 1) developing knowledge for ensuring smart digital climate action that is fair, inclusive and fostering democratic values; 2) improving science-based and co-produced knowledge for carbon reducing remote work commons; and 3) improving science-based knowledge about public acceptability of transformation. The aims will be addressed by the corresponding set of research questions:

1. What types of first-level digital disparities and second-level digital inequalities are prevalent today? In what ways could ICT promote fairness and democratic values? How do we ensure that persons and groups are not left out in current digitalization schemes? How can digitalital-tools become accessible for marginalized groups? How are resilience options to respond to crises not compressed?
2. What actors drive remote working communities and commons in Sweden today? To what extent and in what ways could remote working commons change societal behaviour and discourse? What best practices and co-created principles for decarbonized pathways of remote work could be found? How could emergent 'hybrid green/digital commons initiatives' be designed and scaled up in rural settings and smaller cities to create jobs?
3. What behavioural changes, concerning e.g. flying, eating and commuting, are the public willing to accept? What economic and other incentives will be acceptable and not? How can policies be designed for win-wins, improving health, reducing poverty and decreasing emissions? Will the public accept "nudging" or choice architecture? In what circumstances will it be unacceptable?

6.4.3 Tasks, methods and outputs

Task 4.1. Knowledge ensuring fair digital climate action

It is essential to develop digitalisation and climate policies that safeguard increased participation and redundancy in public-choice options and that mitigate 'digital divides'. A first-level disparity is that a sizable share of the population lacks access to the Internet. In 2014, some 15% of Swedes did not use the Internet, with non-users found in age groups (Colding et al. 2019). Second-level digital inequalities can affect an even greater share of individuals. However, recent advances in Geographic Information Systems, Web 2.0 technologies, and Augmented reality technology have the potential to improve public participation (Lock et al. 2020, Kyttä et al. 2016; Samuelsson et al. 2019, 2020). The involvement of citizens and other stakeholders in governance processes can be seen as an extension of the parliamentary democratic process and may promote that policies are more widely accepted by residents (Colding et al. 2019). Moreover, citizens' knowledge provides a rich source of updated information, with a potential to improve the quality of scientific analysis. Herein socio-political issues of transformation will be analyzed (Scoones et al. 2020) to improve understanding about the digital divide and potential first-level and second-level digital disparities. The task will include extensive literature reviews and mapping of societal attitudes and stated preferences among members in CSOs.

Methods: A combination of scientific-based and co-created research to identify digital divides and unfair conditions. Co-created research will be centred on surveys that capture data on attitudes, on stated preferences of members in selected CSOs, e.g. labour union members. Vulnerable subgroups will be especially approached to identify the range of problems associated with current digitalization schemes. In-depth level interviews will also be conducted with a sample of key informants. Quantitative information and statistical analyses from surveys and interviews will be deduced and further analyzed. The research will also draw from the synthesizing of work and ongoing research on the digital city at the University of Gävle.

Task 4.2. Carbon-reducing remote working commons

Sharing economy, e.g. shared use of sustainable assets and exchange of goods and services, could positively contribute to the objective of FAIRTRANS (Nakano et al. 2020). The emerging trend---accelerated by the pandemic---of flexible remote work has led to exponential growth in digital means, e.g. 'Zoom' and 'Teams', indicating reduced daily commuting and decreased carbon dioxide emissions by up to 43 % (Kylili et al. 2020). Collaborative semi-open remote work offices can be viewed as shared office commons. Such remote working commons are often initiated bottom-up by local entrepreneurs and involve public-private partnership solutions that represent hybrid forms of contractual relations between public, private and civil society sectors (Vincent-Jones 2000). These commons are also often strategically located closer to home, related to walk- and bikeability and where resources are shared (e.g WiFi, printers, conference rooms, receptions, bicycles, carpools) (Novikova 2017), offering reduced energy use. Remote commons represent an interesting example of common property systems (Ostrom 1990), embodying an unexplored property right for creating social mobilisation and climate action in cities and local communities for realization of Agenda 2030 and the Paris Agreement (Colding et al. 2020, Rambaree et al. 2019). Such remote commons are mirrored by a number of urban green commons that exist today in cities (Barthel et al. 2019), including garden and food commons (Colding & Barthel, 2013). New types of hybrid remote commons combined with urban green commons shape urban sustainability discourse (Colding et al. 2019, Colding et al. 2020), and provide new potentials for 'implementing urbanity into rurality', and vice versa by locating e.g. remote working hubs in suburbs and smaller rural towns, mitigating the current pull factor of inner cities.

Methods: A) Mapping of main actors in the Swedish remote working community. B) Studies of the effect that remote work commons have on commuting and travel, and if changed travel behaviour spills over to other fossil demanding behaviours. C) Studies on how companies' environmental performance is changing when an increased proportion of their employees shift to remote work. D) co-creation of principles and best practices for decarbonized remote working commons and remote workers. This will be done by organizing a large portion of the actors in remote work in Sweden and in a series of workshops envisioning best practices for decarbonized pathways using a T-lab design and scenario workshops to also co-create knowledge on emergent 'hybrid green/digital commons' and their up-scaling potential.

Task 4.3. **Global and national surveys and digital tools on attitudes to transformation**

Scientific knowledge about public acceptability of transformative policy will be critically important for crafting discourse and policy for fair and effective climate action. We will undertake a European (20 country) survey and a more detailed national (Sweden; rural and urban) survey specifically focused on attitudes to, and perceptions of, transformation. The surveys will be designed to enable recurrent surveys beyond the scope of FAIRTRANS. The surveys will use novel digital tools and specifically aim to understand attitudes to political and economic transformation in the coming decade and take a systemic view linking environmental policy to inequity issues. **Methods:** The survey design will allow for analysis of how political and ideological issues, socio-economic status and ecological variables interact with attitudes towards transformations needed to meet a carbon budget. Geo-coded responses will be matched to neighbourhoods of respondents to capture socio-economic status. In the political domain the surveys will capture attitudes linked to inequality and trust in government as barriers to transformation. They will also explore attitudes to fiscal incentives to reduce emissions rapidly. The surveys will provide a useful snapshot of attitudes to transformation following the pandemic, which has changed behaviours and business models, often in ways that might reduce emissions. On the economic side, the surveys will explore the transformative impact of the pandemic and the resulting changes in behaviour. It will capture attitudes to responsibility: what do consumers and citizens expect businesses and municipalities should do? FPX, "We Don't Have Time (WDHT)" and AI Sweden will take part in the development of new digital tools for analyzing data of international and national web surveys including an in-house, machine learning and automated web crawler for

aggregating content and data. This work will be cross-fertilized by approaches in tasks 4.1 and 4.2 to improve digital approaches for web-based survey management.

6.4.4 Expected impacts (near and future)

Outputs: Seven scientific papers will be produced, along with popular science papers, reports and blogs.

Impacts and relevance: Communication of results to specific CSOs and societal actors is a central output. Examples of recipients include the Swedish National Digitalisation Council (Digitalseringsrådet) and the work for a sustainable digitized Sweden, as well as labor unions and other CSOs that are linked to FAIRTRANS. A database on attitudes will be produced to inform discourse and policy, aiming to maximise behavioural changes related to the identified budgets (cf. Stoknes 2015), while controlling for rebound effects and for other cognitive biases in relation to climate change (Sörqvist & Langeborg 2019). One workshop per year with key representatives of CSOs and communication officers will be arranged. A strong network of remote working actors will be established (see more in table 3, in section 7).

6.5 WP5. Co-creating fair transformations to a fossil free future

WP5 is led by Associate Prof Mikael Karlsson and Kristina Persson from Global Utmaning. The work will be based on expertise of the researchers Roger Hildingsson (PhD Political Science) and Laura Pareira (PhD Geography and Environmental Science); Associate Prof. Thomas Hahn and Prof. Stephan Barthel, one PhD student, and the experts Eva Marcusdotter and Owen Gaffney.

6.5.1 Background and relevance to the call

WPs 1-4 show that present incremental progress is far from sufficient compared to a fair carbon budget, but also that leapfrogging technologies, social innovations and economic opportunities exist. However, grasping the potentials to the extent required by the carbon budget, require pervasive development of governance and policies, as well as broad stakeholder and citizen support (Geels et al. 2017, Granger Morgan 2016). Concerning governance, much is known about shortcomings in conventional policy processes and instruments, but despite the emergence of concepts such as 'sustainability transition policy' (Rosenbloom et al. 2020), more knowledge is needed on how to achieve truly transformative change (Loorbach et al. 2017, Chaffin et al. 2016, Scones 2016). Similarly, while consumer behaviour, public attitudes, and the roles of stakeholders have been well studied, more knowledge is needed on how to develop governance systems that are not only effectual and efficient, but also considered legitimate in society (Green & Gambhir 2020, O´Rourke & Lollo 2015). In order to meet these challenges, we argue that a co-creative approach is needed.

6.5.2. Aim and research questions

Several questions arise from the insight that there are huge gaps between climate objectives and policy outcomes, despite rich knowledge, available technologies, economic opportunities, enabling policy frameworks and political and public support. For instance, why are present institutional structures and decision-making processes restricting policy development to mainly incremental change? Why do polarizing views on climate policy exist within the public and how could these potentially be overcome? Which threats and opportunities do key stakeholders see follow from transformative strategies? How can citizens be stimulated to participate in transformative change? Departing from these puzzling thoughts, WP5 aims to:

1. identify and analyse barriers and drivers, and explore concrete transformative avenues in climate governance and policy;
2. develop and promote effectual and effective science-based fair transformative strategies and policies;

3. stimulate co-creative learning, engagement and envisioning for fair and fossil free transformations.

The first two aims are achieved by task 5.1 (governance and policy research) and task 5.2 (stakeholder deliberation on policy development), which interact iteratively. The third aim is realised by tasks 5.3-5.5; which are interlinked and informed by task 5.1-5.2, altogether strengthening research, outreach and impact (Dietz 2013). Stakeholders from CSOs and citizen representatives will be involved throughout this WP.

6.5.3. Tasks, methods and outputs

Task 5.1: Barriers, drivers and transformative avenues in climate governance and policy

Climate governance includes all activities by governments and other stakeholders that aim to mitigate or adapt to climate change (Bulkeley & Newell 2015, Hoffmann 2011). Public governance constitutes the backbone against which initiatives and policy arrangements are developed (Arts et al 2006). Despite policies though, trends point in the wrong direction and even forerunner countries fall short compared to the Paris Agreement (Anderson et al. 2020). Various delay mechanisms in science and policy explain these goal-state gaps (Karlsson & Gilek 2019) and factors such as political leadership, ideational change, actor and power relations, and institutional design affect climate governance (Kronsell et al. 2019, Hughes & Urpelainen 2015, Meadowcroft 2007). Climate science denial (Edvardsson Björnberg et al. 2017), policy decision thresholds (Alfredsson & Karlsson 2016) and carbon lock-in (Seto et al. 2016) illustrate barriers, whereas consensus mechanisms (Paglia & Parker 2021), climate policy co-benefits (Karlsson et al. 2020) and policy diffusion (Jordan & Huitema 2014) depict drivers. Considering the nature of policy-making, scholars have suggested 'progressive incrementalism' (Levin et al. 2012) for scaling up policies (Bernstein & Hoffmann 2019). Others emphasize sustainability transitions as avenues for change (Loorbach et al. 2017, Chaffin et al. 2016). Despite this flora of studies, it remains unclear which transformative strategies would be both effective and legitimate. This task aims to identify barriers and drivers, and to explore transformative avenues in climate governance and policy.

Methods: In order to analyse specific policy proposals in-depth, a case study frame will be used (Yin 2003), focusing on Sweden as an advanced environmental state and forerunner in climate policy (Hildingsson 2014, Hildingsson & Khan 2015, Karlsson 2021). First, a review of transformation research on climate governance will be conducted. On that basis, an analytical framework will be derived and used for exploring effectiveness and occurring attitudes to specific policy proposals. These proposals, and concerns that stakeholders and citizens might have, will be identified in both a series of citizen roundtables and the PMO dialogues in task 5.2. The former will also explore the fact that climate issues are highly valued by voters (Andersson et al. 2019), but also strongly polarizing (Martinsson & Weissenbilder 2019). The citizen roundtables will be organized with inspiration from citizen climate assemblies and panels (Willis 2020). The inputs from task 5.2 will guide in-depth studies of specific policies proposals, in an iterative process.

Output: The task will produce at least three scientific articles (which will be part of a doctoral thesis, also based on task 3.2), three op-eds and one policy report.

Task 5.2. Policy development through stakeholder deliberations

Considering the stringent carbon budget, transformations need to be both comprehensive and ground-breaking, even if huge technical potentials are assumed. All stakeholders and citizens will be affected. Despite studies showing that climate policy is economically beneficial (Alfredsson & Karlsson 2016), and despite large co-benefits (Karlsson et al. 2020), there will be both winners and losers, in particular under rapid change. This is unfair and may cause reluctance and resistance that prevent policy development and implementation. Problems can be particularly severe for people who are less empowered and less well-off. Transformative strategies that respect the carbon budget should therefore be sensitive and supportive. We argue that policy development on that

ground is best done through stakeholder deliberations. This task aims to develop and promote transformative policies together with key PMOs and other CSOs, e.g. businesses.

Method: Considering the need to address several aspects of transformation simultaneously, we will form a broad ”arena for trust-building, sense-making, identification of common interests, learning, vertical and/or horizontal collaboration, and conflict resolution” (Folke et al. 2005). We will employ methods from individual trust-building, to social learning and stakeholder dialogue (Hahn et al. 2006), sometimes applying the Chatham House rule. The think tank Global Utmaning has already established collaboration with large PMOs and other CSOs and FAIRTRANS brings these and more to the table, representing over 3 million Swedish members. We will engage extensively from smaller dialogues and consultation to workshops and roundtables. By engaging PMOs/CSOs from diverse areas we address both environmental and socioeconomic aspects, which we consider indispensable for overcoming barriers and grasping opportunities and arrive at fair outcomes. These extensive interactions will be continuously fed with the results from WP1-4 and Task 5.1. The Communication Team and the Policy Group will assist in communication among participants to promote learning and reflection and ensure that results from WP1-4 inform the process. Researchers from WP1-4 have key roles for the workshops, based on our experiences from international conflict resolution within the CBD (Schultz et al. 2018).

Outputs: Several more informal dialogues and consultations take place every year. Each year we organise one larger workshop and 4-6 roundtables with different partners for different issues. This results in a series of concrete policy proposals, published in reports and op-eds and discussed in seminars. Together with the Policy Group we co-create, and finally approve, The Climate Transformation Manifest for a new social contract. This is approved by the Policy Group and all partners are free to sign it. Several scientific articles document this process.

Task 5.3. Triple loop learning within PMOs for change and transformation

Proposals stemming from 5.1-5.2 will concern all citizens. It is therefore important to not only build general support on a national level, but also to co-create mutual learning within and between PMOs as well as in workplaces. Considering the complexity of transformations, we argue that such educational efforts need to go beyond communication and conventional learning, and focus on both the fairness and the fossil free dimensions. Targeting PMOs (trade unions, as well as housing, consumer and environmental organisations), this task aims to develop and implement triple loop learning on transformation within these organisations with over 3 million members.

Methods: Triple loop learning goes deeper than conventional approaches and involves reflecting on learning as such, including re-evaluating underlying norms and paradigms (Johannessen et al. 2019). In addition to what transformation entails in terms of changing working conditions, there is a need to reflect on the purpose of production and consumption as well as a healthy life on a healthy planet.. On that basis, we will co-develop with the PMOs effective learning approaches that engage and empower members/employees in dialogues on transformative change. Practically, a variety of learning concepts (study circles, digital course, webinars, etc.) and various types of course material (written, pod, video, etc.) will be developed with help from the Communication team to train ‘local climate ombudsman’ (cf European Commission 2021). These can in turn train colleagues, thereby promoting lasting effects at workplace settings. We will also invite and interact with the larger adult education organisations, who are responsible for formal training and re-education.

Output: Concepts and course material will be used by all major PMOs in FAIRTRANS. Course activities will reach 5000 persons. Over 75 local climate ombudsman will be trained in districts and companies around Sweden. One scientific paper will document the process.

Task 5.4. Deliberations and triple learning in an international context

Transformations to a fair and fossil free future will not take place in Sweden if other countries do not follow, for several reasons. First, much of climate policies in Sweden is crafted on an EU level, with an often pervasive effect on e.g. Swedish businesses. Examples include the EU's cap and trade system and the European Commission's state aid guidelines. Second, without improved policies and awareness in other countries, export-oriented Swedish companies may face challenges due to unfair competition and weak demand. To some extent, the same issues are relevant on the international level. We therefore argue that the policy development dialogue and educational activities in WP5 need to reach outside of Sweden. Task 5.4. thus aims at expanding the activities and approaches in task 5.2 and 5.3. to European level.

Methods: Departing from task 5.2, we will first set-up an EU level policy dialogue for central CSOs, including trade unions, environmental organisations and CSOs focusing on social and global development issues. A role model for this can be the collaboration within the so-called Spring Alliance, which produced a manifesto for the period 2014-2020. We consider it a high time to further develop that collaboration and manifesto, aiming for a fair and fossil free EU future. In doing so, experiences and networks from e.g. the collaboration Union to Union, as well as from the Spring Alliance will be used. Second, we develop and implement triple loop learning within CSOs on EU level.

Output: We will draft a European Manifesto for Transformation to a Fair and Fossil Free Future and establish dialogues with trade unions and other CSOs in other EU countries. The task will also result in enhanced general commitment to take part in dialogues on societal transformation within the EU.

Task 5.5. T-labs: building visions

While much policy can be shaped by stakeholder deliberations, bringing together citizens and seeking to hear many different voices requires an interactive process of knowledge co-production through the design of transformative spaces (Pereira et al. 2019). This task aims to co-produce visions by testing policy proposals from previous tasks through innovative, participatory workshops called Transformation Labs. Questions that can be addressed during such futuring processes include e.g. what citizens expect from fair transitions towards fossil free livelihoods.

Method: We will undertake to create a series of transformative spaces, i.e. collaborative environments where experimentation with new configurations of social-ecological systems can occur (Pereira et al. 2019). Examples will include visioning exercises to build scenarios of fossil free futures (Raudsepp-Hearne et al. 2019). We will also conduct a series of T-labs and bring together e.g. innovators, change-makers and policy-makers to develop solutions (WP4). These will follow an approach developed during T-labs in e.g. South Africa and the UK (Ely et al. 2020), which will entail working closely with participants and not least including young entrepreneurs, youth and other often underrepresented participants in climate action.

Outputs: Two scientific articles, and five visions of a fair fossil free future Sweden, published and discussed.

6.5.4 Expected impacts (near and future)

WP5 will accelerate transformative change through advanced scientific knowledge on governance and not least through enhanced CSO and citizen engagement in dialogue, co-crafting of policies and local learning. This link between science and society is fundamental in FAIRTRANS. Participating PMOs have over 3 million members, which points out the huge potential of WP5 to nurture social capital and build support for transformative change. See further table 3 on how WP5 will help lowering thresholds for policy-making.

***Table 2**. Summary of deliverables in the programme year 1-4*

	Scientific outputs		Popular science and policy outputs			Stakeholder collaborations
	Scientific papers*	Conference presentations	Articles in CSOs magazines; op-eds etc	Blog posts	Co-created Policy-reports	Workshops, Roundtables T-Labs, etc. with CSOs.
WP1	**4**	**2**	**1**	**2**	**0**	**1**
WP2	**7**	**5**	**4**	**5**	**2**	**5**
WP3	**5**	**5**	**5**	**8**	**2**	**6**
WP4	**7**	**5**	**5**	**11**	**4**	**8**
WP5	**7**	**5**	**8**	**30**	**6**	**20**

*Submitted. In addition, 1 doctoral thesis will be produced (linked to tasks 3.2 and 5.1)

8. Communication and impact

FAIRTRANS identifies CSOs as important users of our results. Some of the largest Swedish CSOs, with key roles for sustainability transformations, are represented in this proposal and will be part of the co-production of knowledge. The programme will require strong internal communication, stakeholder engagement and collaborative learning across the working groups. Many key outputs will be in the form of peer-reviewed academic papers (open access). Other key outputs include public surveys on attitudes which have the potential for mass media interest. As university teachers we also see students as important stakeholders. At the heart of communications is a deep understanding of the audiences that need to be reached and the channels to reach them. We will ensure that both scientific output and output relevant to other stakeholder groups will be featured in relevant channels, including policy, media, and education. The communications strategy will target these groups:

1. trade unions and employees
2. other popular movement organisations (PMOs)
3. other parts of civil society, especially business leaders and entrepreneurs
4. students
5. government agencies and indirectly political parties

WP5 is devoted to communication within the first three groups above, as they are committed partners to this proposal. WP2-4 also includes various degrees of participation from civil society.

Our communication team

Stockholm Resilience Centre has a professional division for external communication https://www.stockholmresilience.org/meet-our-team.html?type=Communication We propose the global sustainability analyst and writer Owen Gaffney as Head of Communication. He has an excellent track record including developing and implementing ambitious national and international communications strategies for example for the Global Commons Alliance, Stockholm Resilience Centre, the Exponential Climate Action Roadmap, the International Geosphere-Biosphere Programme and Future Earth (see CV). FAIRTRANS will have a small Communication Team in charge of science and CSO communication, development of web pages for the Mistra FAIRTRANS programme, extensive use of films/videos/blogs and writing annual reports; the latter will be produced together with Global Utmaning who have close links with several of the participating CSOs. Moreover, Associate Professor Mikael Karlsson, head of the Climate Change Leadership initiative at Uppsala University, will help with advice on communication. He has over 25 years of experience on environmental communication in practice, from local to global level, including writing, publishing and commissioning hundreds of popular articles and reports, and arranging and moderating hundreds of seminars etc.

Co-production of knowledge (policy, civil society)

FAIRTRANS is designed around co-production of knowledge. A key output from the initiative will be a suite of co-produced visions of a fair fossil-free future for Sweden. The communication team will assist WP leaders and CSOs and design a series of products to engage with these visions through a range of media: film/video, online, print and explore interactivity with audiences. This will form a new knowledge bank for all audiences. Key audiences for this initiative are workers. The transformation to zero emissions will affect all economic sectors with major implications for workers. Without careful management and communication workers risk becoming losers in the transformation. Indeed, it is increasingly clear that if the climate transition is not viewed as fair it is less likely to succeed. We will work with trade unions, housing and consumer organisations to build a roll-out strategy to engage their members and similar audiences. To a large extent the programme's main outcomes, scientific insights/scenarios and policy development, will be implemented as a Trojan Horse, i.e. within large PMOs. The theory of change is that when large PMOs, representing workers and consumers, have formulated fossil-free visions which are attractive to their members, it will become much easier for political parties to implement effective and cost-efficient policies and

investments. Hence we target political parties mainly indirectly. The fossil-intensive industry is already organised in the initiative Fossil-free Sweden and has produced several roadmaps towards carbon neutrality, but the large PMOs have so far not entered equally institutionalised collaborations. FAIRTRANS will lay the ground for this and key for this is co-development of policies and communication strategies within these PMOs (to their own members) and externally. Our communication team will also help Swedish PMOs in their international collaboration (Task 5.3)

***Table 3**. Detailed table on out-comes and impacts of the FAIRTRANS WP-structure.*

Aims WP1	**Tasks WP1**	**Outputs WP 1**	**WP1 impact four years**	**FAIRTRANS impact eight years** Sweden and other countries make national carbon budgets based on fairness and realistic assumptions on NETs. Increased nation-wide climate action Widespread hope in reaching Paris accord Political discourse that goes beyond the green growth and decoupling narrative. Enhanced adaptive capacity in forests and forestry to climate change impacts. Discourse on reconciling bioenergy conflicts nationally and with the EU.
Model current Swedish policy scenarios and…	Earth system-informed National Carbon Budgets and trajectories: data collecting and analysis for national carbon budget under different future climate scenarios	Report on various pathways for reaching net-zero carbon goals with estimation on total carbon budget, land-use change, water demand, and technological shifts.	Insight into Swedish carbon budgets under short and long term under different future economic and climate trajectories	
assess their potentials to achieve the Paris target	Gap analysis at national level: assessment of various pathways for reaching net-zero carbon goals		Multi-stakeholder based pathway development and assessment reaching Swedish decarbonization goals	
Develop new pathways	Model potentials to transform under current sectoral efforts for years 2030, 2050 and 2100		Workshops with SCOs on pathway scenarios allowing optimized transformation of national sectors with minimal global socio-ecological impacts.	
Aims WP2	**Tasks WP2**	**Outputs WP 2**	**WP2 impact four years**	
Explore measures and investments needed	Identify the remaining gaps to net zero emissions, and analysis of technical solutions across various sectors.	Technical 2045 scenario for Swedish decarbonization, integrated across sectors. A policy framework for analyzing investments.	Workshops with CSOs on carbon return on investments	

Analyze potential cuts in carbon dioxide emissions	Analyze carbon emissions from investments, CROI, estimates of economic effects. Develop a policy framework	An investment plan for an effective transformation. A quantitative technical roadmap for a fair transformation within the carbon budget.	Key actors are beginning to understand that the massive investments in infrastructure put a limit on the carbon footprint of private consumption	Emerging market for buying green negative emissions in Sweden. More sustainable agriculture. Renewed negotiations between key climate actors based on carbon budgets Powerful CSO alliances for climate action A national node for climate action among digital commons The education of thousands of citizens and of nearly a hundred climate ombudsman, within PMOs representing over 3 million members has transformed climate discourses from winners and losers to a joint vision, leaving nobody behind. FAIRTRANS shaping the national climate policy arena. Accelerated policy-making; CSOs continue to act together more frequently, in new forms CSOs more ready and alert to discuss and promote real climate action Enhanced public acceptance to transformations needed to meet Paris accord FAIRTRANS approaches and findings have an
Establish pathway of long term fairness and welfare	Evaluate cross sectoral roadmaps developed by industry within the Fossil free Sweden initiative.	A report on a quantitative technical roadmap for a fair transformation within the carbon budget. 3 Workshops.	A co-created framework for national roadmaps based on a common understanding of Sweden's (globally) fair carbon budget.	
Analyze impacts on economic sustainability	Analyze discourse of green/sustainable growth paradigm.	A discourse analysis and decarbonisation scenarios beyond growth. Scenario workshops with CSOs (will feed into WP5),	Understanding of the potential for sustainability and well-being beyond GDP	
Analyze interactions with sustainable development goals (SDG)	Model impacts of different interventions on SDG achievements.	A new digital model-tool.	Increased understanding of nation-wide socio-economic and environmental consequences of different policy options.	
Aims WP3	**Tasks WP3**	**Outputs WP 3**	**WP3 impact four years**	
Explore avenues to make Swedish forestry and agriculture sustainable carbon sinks	Quantify climate benefits from standing forests and from forestry. Modelling cost-effective pathways.	Resilience analyzes in safeguarding climate benefits. Stakeholder dialogues to overcome contested issues in Sweden.	CCF and other alternatives to clear-cutting will be considered as part of the tool-box in Swedish forestry.	
Reconcile conflicts on how to use bioenergy within the carbon budget	Identify the largest common denominators, and conduct trust-building round table dialogues.	2 op-eds, part of doctoral thesis, reports from four roundtables and one Delphi consensus process.	Richer mutual understanding among key stakeholders and policy-makers in the climate and bioenergy debate.	
Connect investors/emitters with farmers	Analyze if regenerative agriculture can be co-created with diverse stakeholders. Develop a digital platform.	A digital platform for connecting investors/emitters with farmers. 1 report for users.	Intensive stakeholder collaboration initiated. Business model for the Nordic countries green NETs.	
Aims WP4	**Tasks WP4**	**Outputs WP4**	**WP4 impact four years**	
Ensure fair digital climate action	Collecting data on Remote work commons. Literature review on wicked problems and digital inequalities.	1 Report about Swedish Remote work with contact information. 2 blogs informing of preliminary findings.	Increased awareness and ways to mitigate digital inequalities in climate action	
Support carbon-reducing remote work and commons	Digital tool development for co-creation with CSOs. Analyze best practices for climate action and to	2 workshops and plenary with key actors on how to create fair digital climate strategies for Sweden. A global digital	FAIRTRANS shape cuts in commuting and share findings on the role of remote digital commons for rural development	

	mitigate rural depopulation.	platform of key remote leaders.		impact beyond Sweden
Capture societal attitudes towards transformation	Web-surveys on attitudes towards transformation. In the EU and in Sweden.e	Communication news from surveys. Database on attitudes towards transformation.	Plenary session with the Swedish National Digitalization Council (Digitalseringsrådet) and the government's work for a sustainable digitized Sweden.	FAIRTRANS partners have catalysed a policy framework for green negative emissions in Swedish forestry including incentives for farmers.
Aims WP5	**Tasks WP5**	**Outputs WP5**	**WP5 impact four years**	The EU Green Deal is focusing on achieving the 55% target 2030 and puts more emphasis to control rebound effects.
Explore transformative governance avenues	Identifying barriers and drivers, and exploring transformative avenues, in climate governance and policy	1 popular report; 3 op-eds	Discussions initiated on the links between theoretical reasoning and practice; debate on a set of climate governance strategies and policies.	
Promote fair and effectual policies	Developing and co-creating strategies and policies in dialogue with key Swedish PMOs and other CSOs.	Policy proposals, reports and op-eds; a broadly supported **Swedish Manifesto for Transformation to a Fair and Fossil Free Future**	Political deliberations on policy proposals presented jointly by a group of CSOs from different fields; improved collaboration between CSOs	
Stimulate learning	Triple loop learning among local PMOs in Sweden	A series of courses; educational activities; training of climate representatives in workplaces of CSOs locally	Enhanced knowledge on and commitment to transformative societal change.	
Activate fair and fossil free futures	Co-producing FAIRTRANS-visions with SCOs and other actors	Film on five visions of a fair fossil free future	Enhanced motivation to act among citizens	
Spread FAIRTRANS action to EU	Workshops and learning activities on EU level	Drafting a European Manifesto for Transformation to a Fair and Fossil Free Future	Political deliberations on EU level on policies proposed jointly by central CSOs	
Aims WP0	**Tasks WP0**	**Outputs WP0**	**WP0 impact four years**	
Governing and Managing FAIRTRANS	Execute administration, coordination and communication	Excellent organization. Deliverables produced in time. Four annual reports. Final report.	World class science communication. Many seminars and workshops. 7 Assembly Meetings. Final National Conference.	

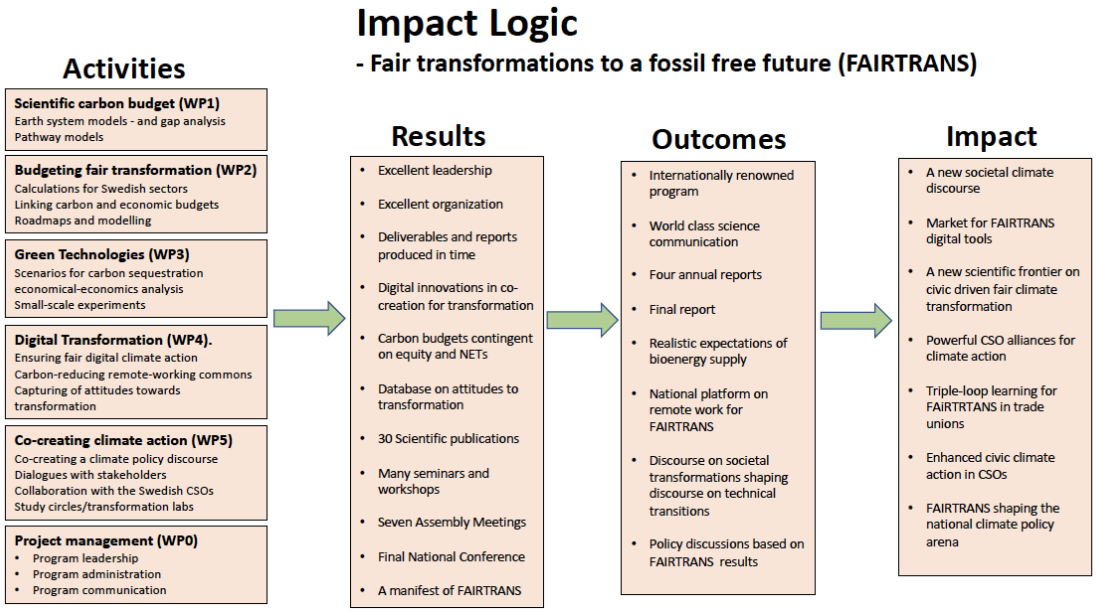


Figure 3. Impact Logic of FAIRTRANS