LOCOMINAR

Five science-based tips for the EU’s green transition

22nd of October 2021, 10 to 11.30 (CEST)

University of Valladolid, European Environmental Bureau, University of Pisa, BC3 Research

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 821105.

Agenda

- **10.00 - 10.10**
  - Welcome and introduction
- **10.10 - 11.00**
  - Presentation of LOCOMOTION Policy Recommendations
    - i. Tip 1: No space for error (Dirk-Jan Van de Ven, BC3 Research)
    - ii. Tip 2: More renewables, less energy (Luis Javier Miguel González, University of Valladolid)
    - iii. Tip 3: Navigating the future of electric vehicles (Ignacio de Blas, University of Valladolid)
    - iv. Tip 4: Avoiding the inequalities of green growth (Tiziano Distefano , University of Pisa)
    - v. Tip 5: Remove carbon removals (Margarita Mediavilla, University of Valladolid)
- **11.00 – 11.30**
  - Q&A’s and debate

Doing the locomotion

LOCOMOTION is developing sophisticated models and tools to assess the socioeconomic and environmental impact of different policy options in order to help society make informed decisions about the transition to a sustainable, low-carbon future.

LOCOMOTION's models will assess:

- **The European Green Deal**
- **The transition to climate neutrality by 2050**
- **The effects of pandemics**
- **And much more**

UNIPI SDEWES AEA BC3

CESAR UoI CRES FC.ID

UNU-EHS EEB CREAF CARTIF INN

Introducing WILIAM

WILIAM stands for Within Limit Integrated Assessment Model. It is made up of several interrelated models.

- Economy and finance
- Renewable and non-renewable energy
- Raw materials
- Energy infrastructure and technologies
- Environment
- Climate change
- Population and society

Five science-based tips for the EU's green transition

Tip 1: No space for error : The potential land impacts of solar energy

Friday the 22nd October

Dirk-Jan van de Ven

Basque Centre for Climate Change

This project has received funding from
the European Union's Horizon 2020 research and innovation
programme under grant agreement No 821105.

Background

- Important role of solar energy in EU decarbonisation pathways
  - Abundant solar resources
  - Zero emissions
  - Less visible and noisy than wind energy
  - Cheap: in many places cheapest source of new energy capacity, with costs still declining

- Land occupation as main drawback
  - Solar energy needs **large amount of horizontal space** to capture sunlight
  - Most land in Europe has high productive or natural value
  - With more expansion, **more competition with existing land uses**
  - **Rooftop space insufficient** to meet energy demands
  - **Large scale import** from Africa **unrealistic**

Study

scientific reports

Check for updates

OPEN

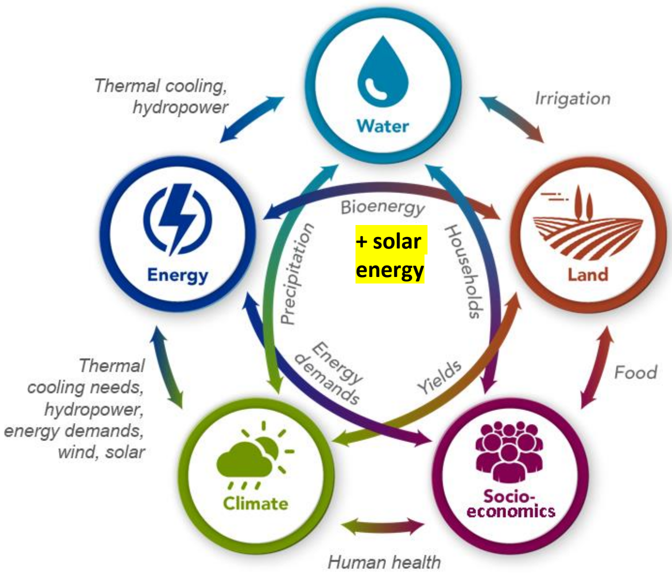
The potential land requirements and related land use change emissions of solar energy

Dirk-Jan van de Ven[1✉], Iñigo Capellan-Peréz[2], Iñaki Arto[1], Ignacio Cazcarro[1,3], Carlos de Castro[2], Pralit Patel[4] & Mikel Gonzalez-Eguino[1,5]

Although the transition to renewable energies will intensify the global competition for land, the potential impacts driven by solar energy remain unexplored. In this work, the potential solar land requirements and related land use change emissions are computed for the EU, India, Japan and South Korea. A novel method is developed within an integrated assessment model which links socioeconomic, energy, land and climate systems. At 25–80% penetration in the electricity mix of those regions by 2050, we find that solar energy may occupy 0.5–5% of total land. The resulting land cover changes, including indirect effects, will likely cause a net release of carbon ranging from 0 to 50 gCO_2/kWh, depending on the region, scale of expansion, solar technology efficiency and land management practices in solar parks. Hence, a coordinated planning and regulation of new solar energy infrastructures should be enforced to avoid a significant increase in their life cycle emissions through terrestrial carbon losses.

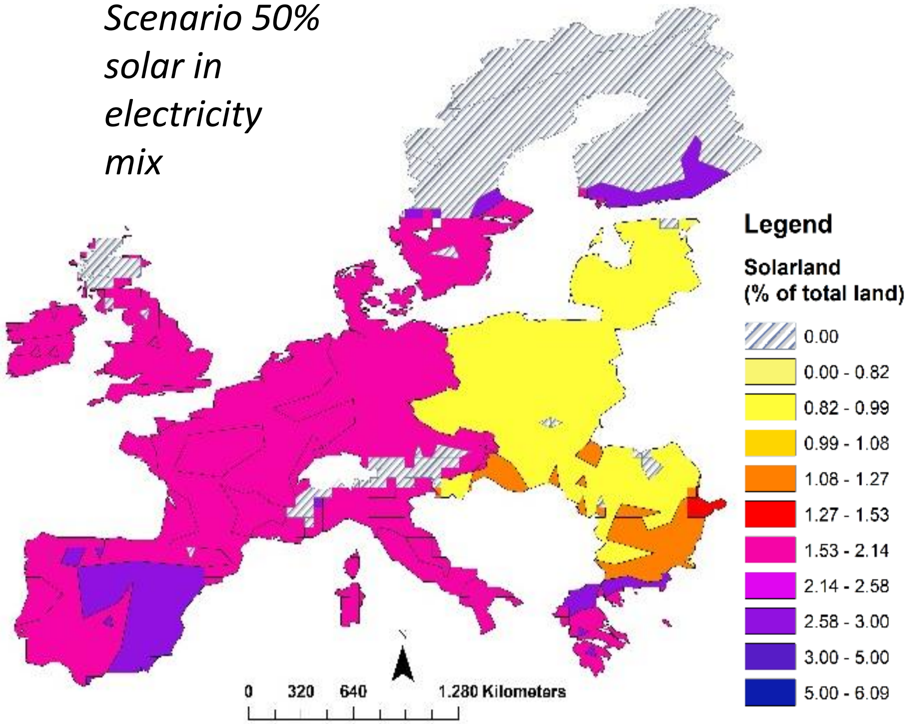
https://doi.org/10.1038/s41598-021-82042-5

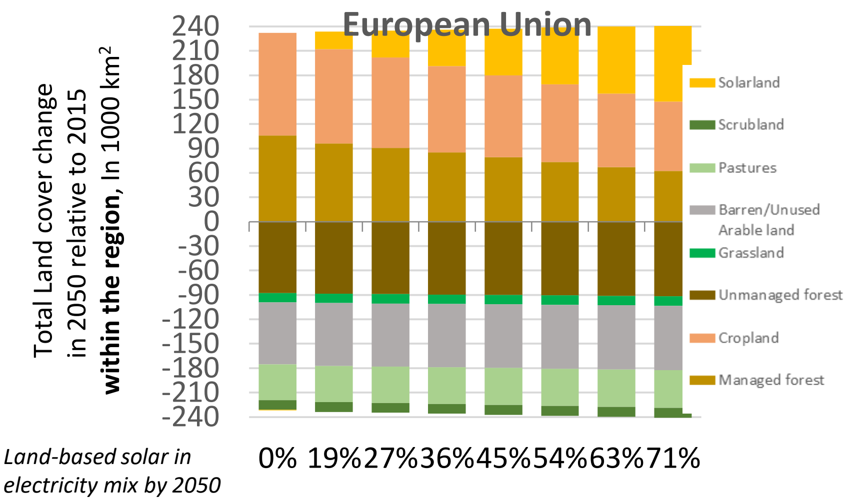
Global Change Analysis Model (GCAM)

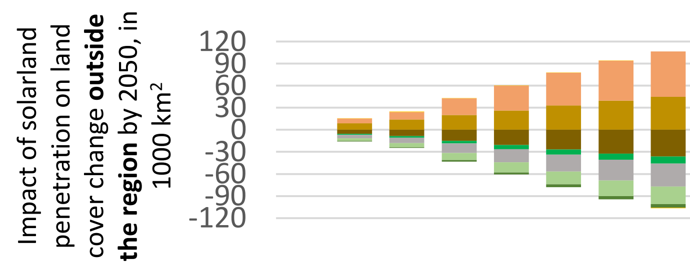


Land occupation

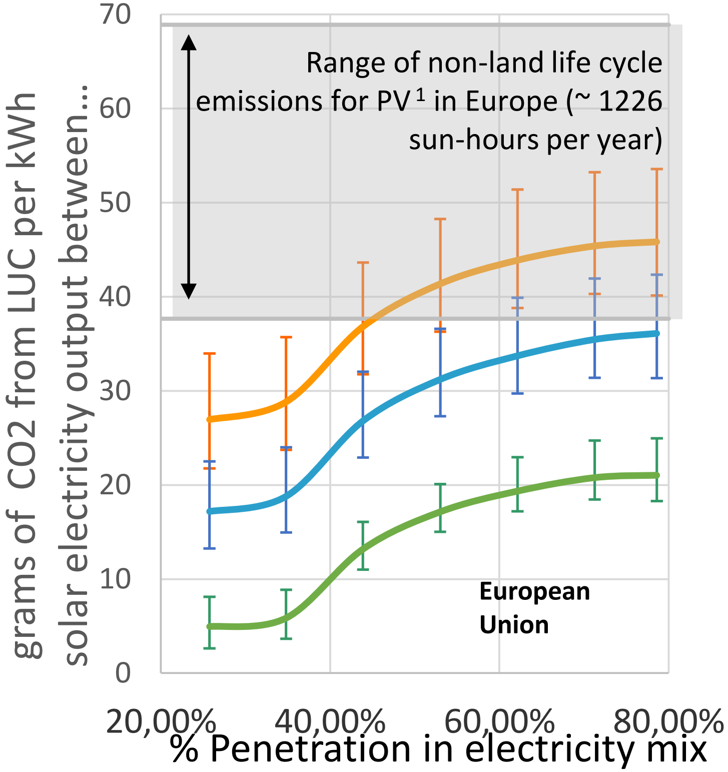
Scenario 50% solar in electricity mix







Land use change emissions



Seeding and management as pastures

Puertollano, Spain

Conclusions

- Solar energy in Europe not without impacts
  - May occupy an **area as big as total urbanised land** nowadays
  - Likely **displaces natural land** within and outside Europe (indirectly)
  - The higher the penetration, the more land use change emissions per kWh generated

- But context is important:
  - Land use change emissions **4 to 16% of the CO_2 emissions from natural gas** fired electricity
  - Land use change emissions 6 to 25 times lower than biomass-fired electricity

- Recommendations:
  - Policies on **siting and land management** of solar parks
  - As much generation as possible in **urban areas**
  - **Reduce energy demand**!

Five science-based tips for the EU's green transition

Tip 3: More renewables, less energy:
The energy cost of the transition to renewable energy

Friday the 22nd October

Luis Javier Miguel

University of Valladolid

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 821105.

Introduction. The energy we need to use energy.

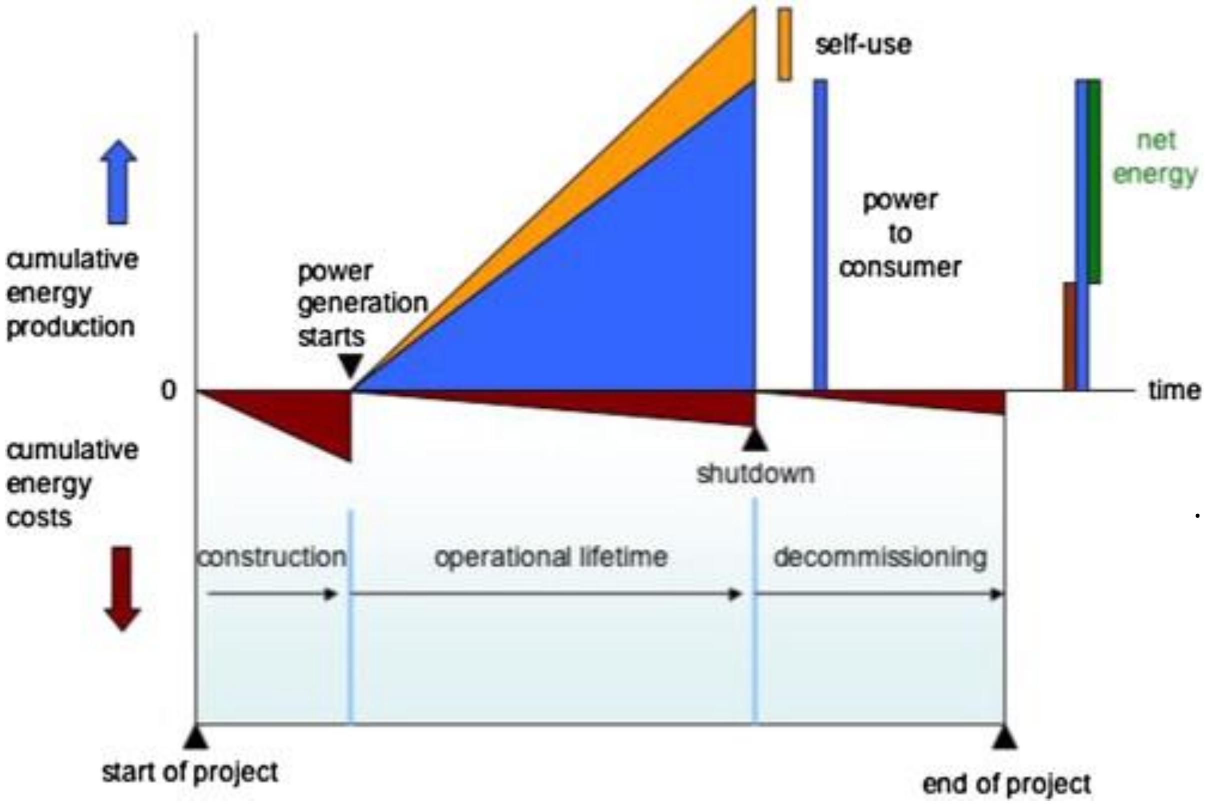
To get the final energy that we use, it is necessary to spend energy first.

- We need energy to:
  - ✓ Extract the primary energy (oil, coal, natural gas, wind, solar ...)
  - ✓ Transform energy into its final form (electricity, heat, ...)
  - ✓ Transport energy

- But the facilities for the production, transformation and transport of energy (wind generators, solar panels, thermal power plants, power lines ...) also require:
  - ✓ Energy for the construction of the facilities
  - ✓ Materials (copper, aluminium, steel, chromium, manganese, neodymium, ...)

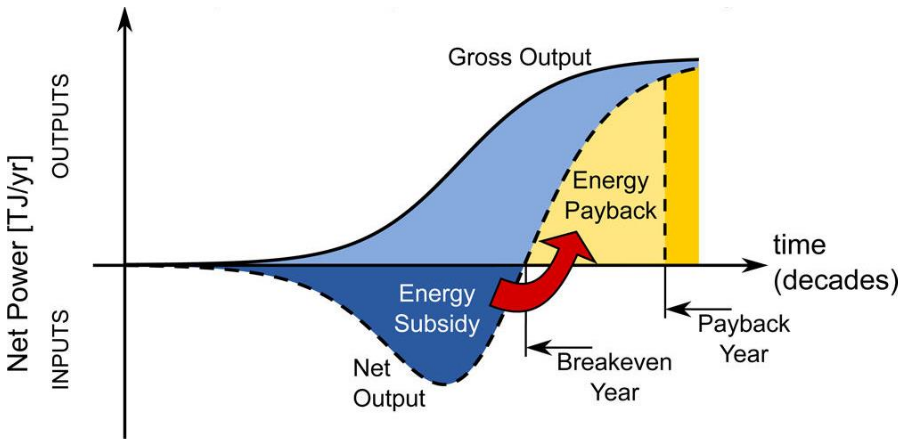
- The extraction of these minerals also requires
  - ✓ Energy (that increases when the ore grade decreases in the mines….).
  - ✓ Facilities and their materials
- …….

The importance of net energy analysis



Source. Kubiszewski I et al., 2009

EROI (or ERoEI): Energy returned on energy invested



Dale&Benson 2013

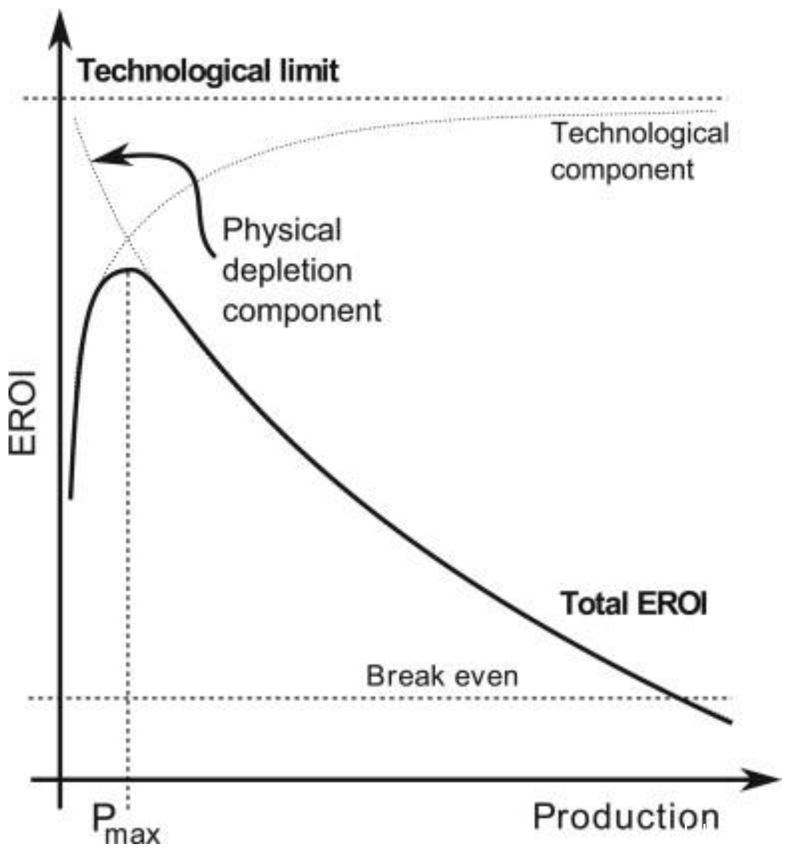
EROI over the lifetime of an energy technology:

$$EROI = \frac{Total\ energy\ returned}{Total\ energy\ invested}$$

Technology	Type of energy product	EROIst
Large Hydropower	Electricity	10 – 300
Fossil fuels	Primary	35 – 50
Wind offshore	Electricity	7 – 20
Wind onshore	Electricity	5 –- 35
Solar PV	Electricity	3 – 8

EROI measures the energy "profitability" of each energy resource
Globally, the energy transition leads to an energy mix of lower EROI technologies

EROI of each energy source over time

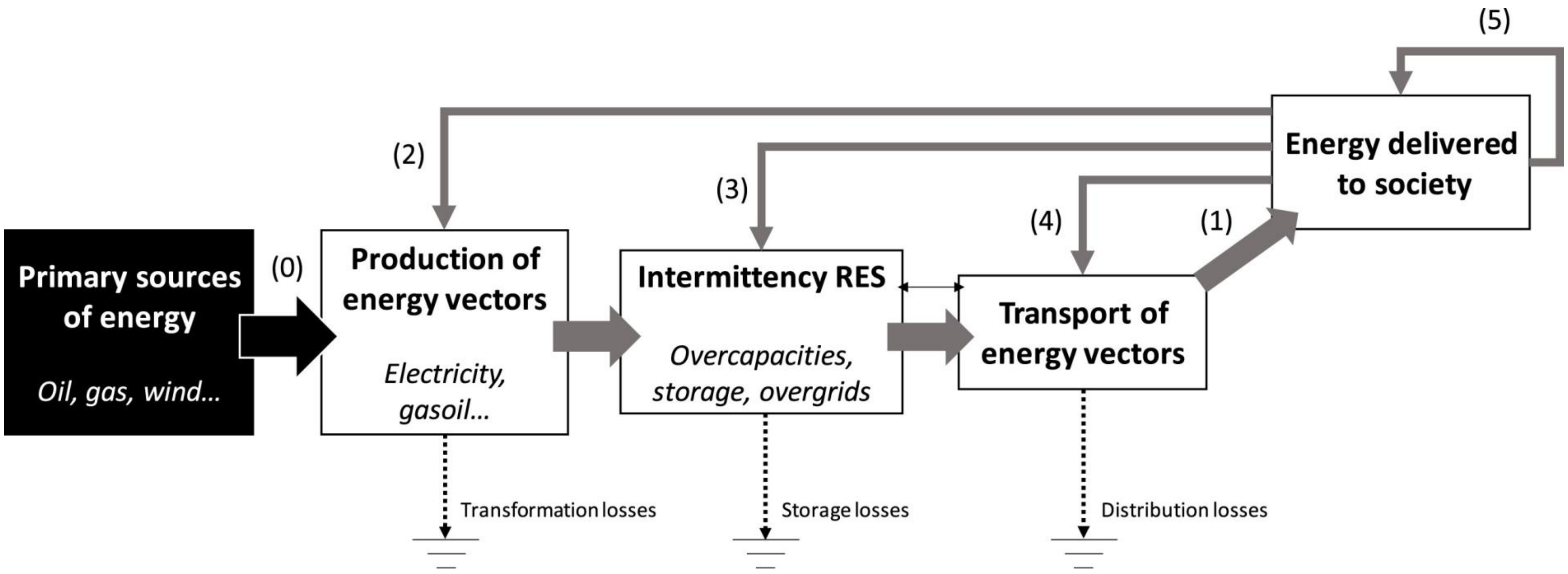


Source: Dale, M. et al., 2011

The temporal evolution of the EROI of each energy source depends on two components:

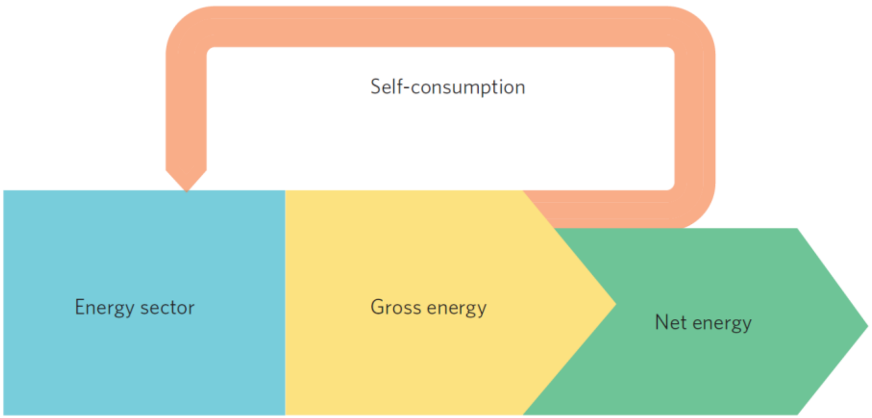
- Technology improves over time, but limited.
- The "quality" of the energy resource decreases over time.

EROI overview of the energy system



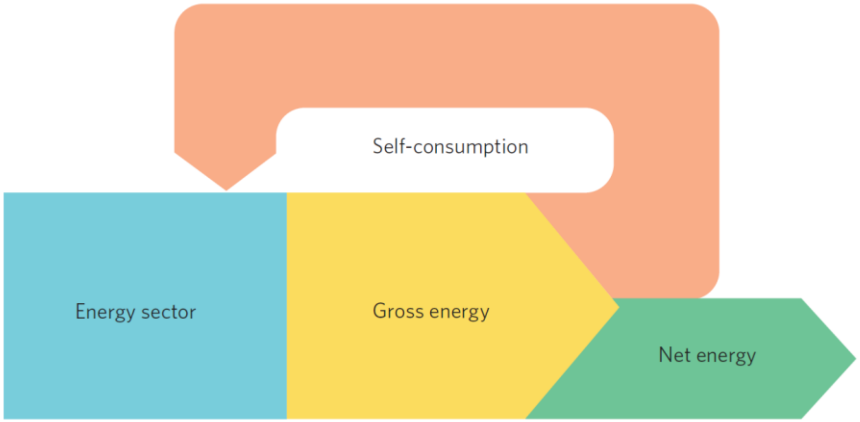
The energy transition will lead to a decrease in EROI

"High" EROI (last decades):



Current industrial modern countries

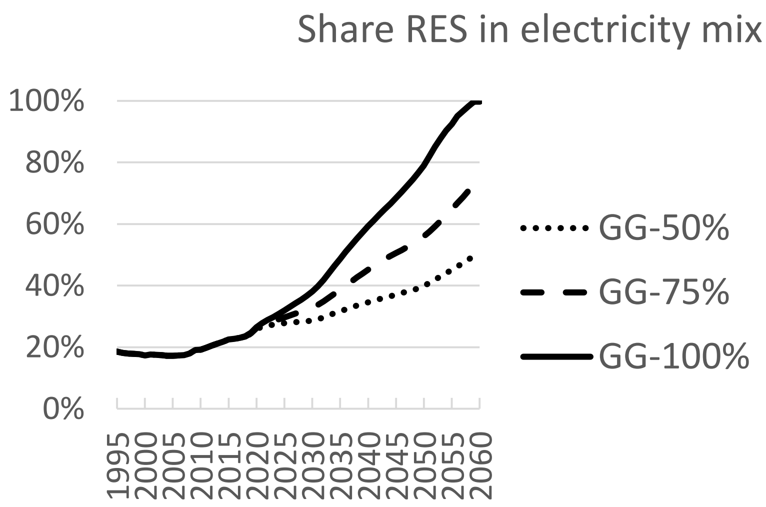
"Low" EROI (near future):

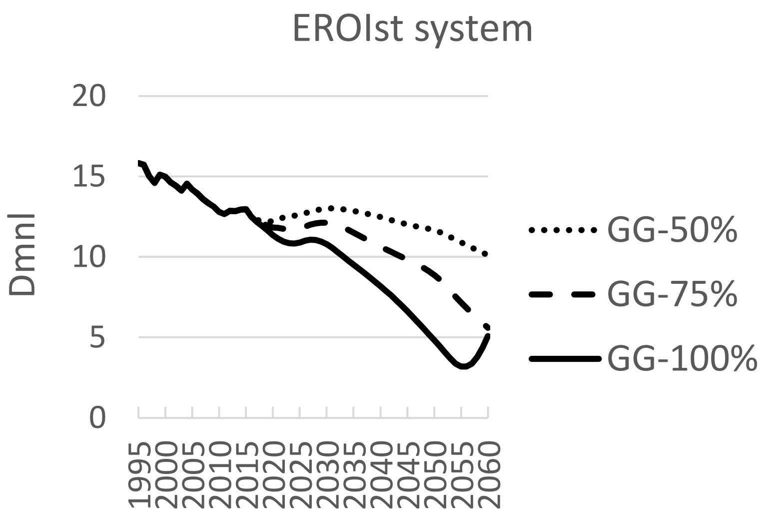


Dynamic EROI of the energy system: $EROI(t) = \frac{\sum energy\ returned(t)}{\sum energy\ invested(t)}$

Results

- 3 Green Growth type scenarios reaching 50, 75 and 100% RES share by 2060:





EROIst thresholds identified in the literature to sustain complex human societies:
~ 10 (Hall et al., 2009) ~ 5 (Brandt et al., 2017)

LOCOMOTION

Conclusions

- Energy transition will require significant monetary and physical investments

- Fast transition to RES, as required to mitigate climate change, will:
  - Reduce, at least temporary, the amount of net energy available to the society
  - Induce re-materialization of economy rather than its dematerialization
  - More energy losses (due to more energy transformation and transport processes)

- EROI is expected to decline during the energy transition. Sustainability risk for our complex society model?

Recommendations

- Policies aimed at optimizing the management of mineral resources (reduction of use, substitution, recycling, ...)
- Need for medium and long-term planning of the energy transition with a global assessment perspective (materials, environmental impact, land-use, social equity, ...)
- Policies aimed at reducing energy demand
- Policies aimed at promoting sustainability and local development by limiting dependence on a complex global society

Data and figures from published papers

Energy Strategy Reviews 26 (2019) 100399

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: www.elsevier.com/locate/esr

Dynamic Energy Return on Energy Investment (EROI) and material requirements in scenarios of global transition to renewable energies

Iñigo Capellán-Pérez[a,b,*], Carlos de Castro[a,c], Luis Javier Miguel González[a,b]

[a] Research Group on Energy, Economy and System Dynamics, Escuela de Ingenierías Industriales, Paseo del Cauce s/n, University of Valladolid, 47011 Valladolid, Spain
[b] Department of Systems Engineering and Automatic Control, Escuela de Ingenierías Industriales, Paseo del Cauce s/n, University of Valladolid, 47011 Valladolid, Spain
[c] Department of Applied Physics, Escuela de Arquitectura, Av Salamanca, 18, University of Valladolid, 47014, Valladolid, Spain

research article / artículo de investigación

Analysis of the material requirements of global electrical mobility
Daniel Pulido-Sánchez, Iñigo Capellán-Pérez, Margarita Mediavilla-Pascual, Carlos de-Castro-Carranza y Fernando Frechoso-Escudero

Analysis of the material requirements of global electrical mobility

Análisis de los requerimientos materiales de la movilidad eléctrica mundial

Daniel Pulido-Sánchez[1], Iñigo Capellán-Pérez[2], Margarita Mediavilla-Pascual[3], Carlos de-Castro-Carranza[4] y Fernando Frechoso-Escudero[5]

Universidad de Valladolid. EII. [1] Grupo de Energía, Economía y Dinámica de Sistemas (GEEDS). [2] Departamento de Ingeniería de Sistemas y Automática.
[3] Departamento de Ingeniería Eléctrica. Paseo del Cauce, 59 - 47011 Valladolid (España).
[4] Universidad de Valladolid. Escuela de Arquitectura. Dpto. de Física Aplicada. Av. Salamanca, 18 - 47014 Valladolid (España).

DOI: https://doi.org/10.6036/9893 Received: 03/08/2020 • Reviewing: 02/09/2020 • Acepted: 03/11/2020

energies

MDPI

Article

Standard, Point of Use, and Extended Energy Return on Energy Invested (EROI) from Comprehensive Material Requirements of Present Global Wind, Solar, and Hydro Power Technologies

Carlos de Castro [1,2,*] and Iñigo Capellán-Pérez [1]

1 Research Group on Energy, Economy and System Dynamics, Escuela de Ingenierías Industriales, University of Valladolid, Paseo del Cauce s/n, 47011 Valladolid, Spain; inigo.capellan@uva.es
2 Department of Applied Physics, Escuela de Arquitectura, University of Valladolid, Av Salamanca, 18, 47014 Valladolid, Spain
* Correspondence: ccastro@termo.uva.es

Received: 24 April 2020; Accepted: 6 June 2020; Published: 12 June 2020

check for updates

Five science-based tips for the EU's green transition

Tip 3: Navigating the future of electric vehicles

Friday the 22nd October

Ignacio de Blas (Uva)

This project has received funding from
the European Union's Horizon 2020 research and innovation
programme under grant agreement No 821105.

Navigating the future of electric vehicles

- The policy recommendations in Tip 3 entitled “Navigating the future of electric vehicles” are obtained from a paper published in the scientific journal “Energy Strategy reviews”.

Energy Strategy Reviews 32 (2020) 100543

Contents lists available at ScienceDirect

Energy Strategy Reviews

journal homepage: http://www.elsevier.com/locate/esr

The limits of transport decarbonization under the current growth paradigm

Ignacio de Blas [a,b,*], Margarita Mediavilla [a,b], Iñigo Capellán-Pérez [a], Carmen Duce [a]

[a] Group of Energy, Economy and System Dynamics of the University of Valladolid (GEEDS), Valladolid, Spain
[b] Department of Systems Engineering and Automatic Control, Escuela de Ingenierías Industriales, Paseo del Cauce s/n, University of Valladolid, 47011, Valladolid, Spain

ARTICLE INFO

Keywords:
Energy transition
Decarbonization
Electric vehicles
Lithium
Degrowth

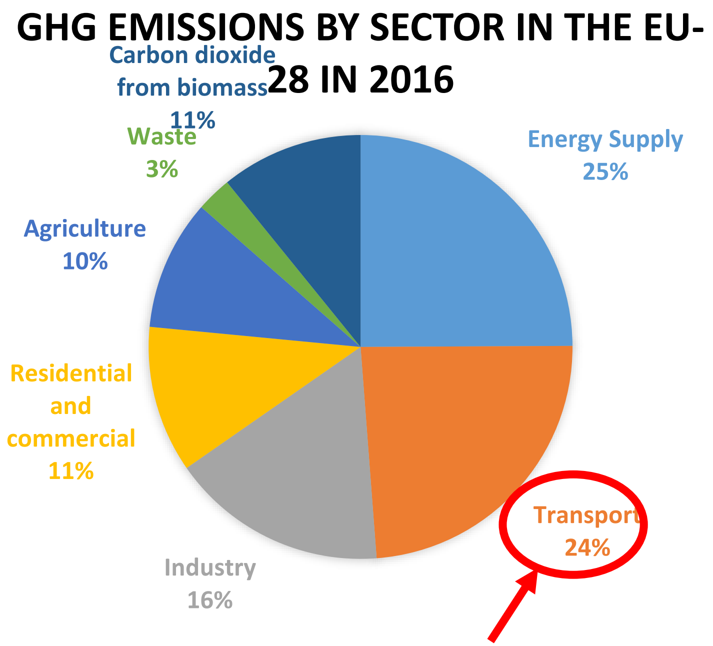
ABSTRACT

Achieving ambitious reductions in greenhouse gases (GHG) is particularly challenging for transportation due to the technical limitations of replacing oil-based fuels. We apply the integrated assessment model MEDEAS-World to study four global transportation decarbonization strategies for 2050. The results show that a massive replacement of oil-fueled individual vehicles to electric ones alone cannot deliver GHG reductions consistent with climate stabilization and could result in the scarcity of some key minerals, such as lithium and magnesium. In addition, energy-economy feedbacks within an economic growth system create a rebound effect that counters the benefits of substitution. The only strategy that can achieve the objectives globally follows the Degrowth paradigm, combining a quick and radical shift to lighter electric vehicles and non-motorized modes with a drastic reduction in total transportation demand.

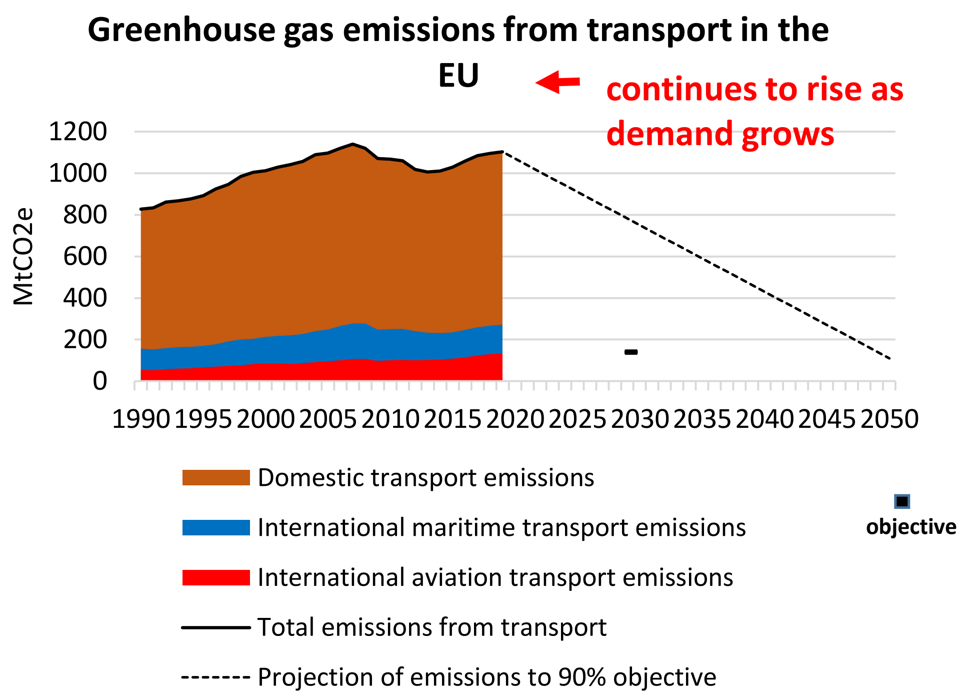
de Blas, I., Mediavilla, M., Capellán-Pérez, I., Duce, C., 2020. The limits of transport decarbonization under the current growth paradigm. Energy Strategy Reviews 32, 100543. https://doi.org/10.1016/j.esr.2020.100543.

LOCOMOTION

Navigating the future of electric vehicles



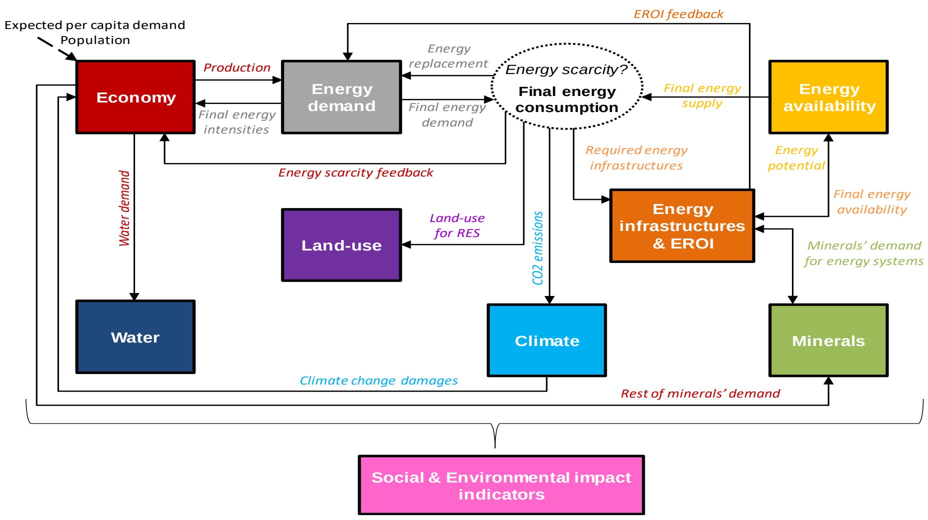
(*Own elaboration from EEA data)*



Navigating the future of electric vehicles

- Several simulations have been carried out in the IAM MEDEAS-W (H2020-LCE-2015-2. 691287) to evaluate policies to achieve this objective.

MEDEAS-W model schematic overview



Important implications:

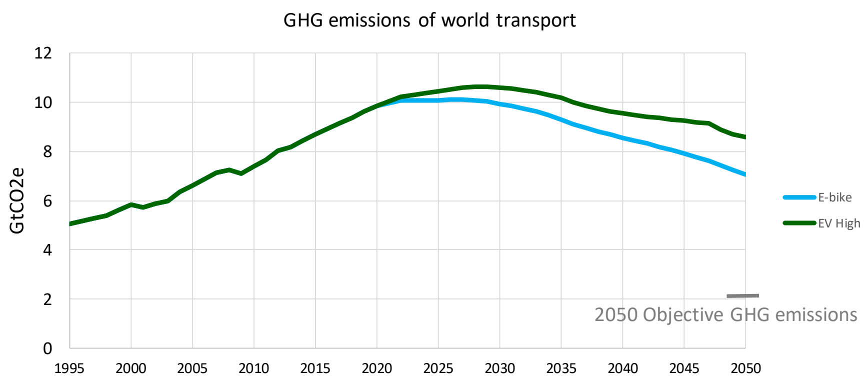
- Global model
- Capture complexities of the system
- Combine technological change policies with lifestyle change policies

Navigating the future of electric vehicles

A major pillar of the EU's strategy is to transition to so-called **clean vehicles**

Two simulations in MEDEAS-W:

- **EV-high:** hypothetical scenario of very high electrification in inland transportation
- **E-bike**: a radical change in mobility where cars are largely removed in favour of electric motorcycles, bicycles and non-motorised modes



Ratio of global cumulated primary extraction of aluminium, copper, lithium and manganese from mines versus global reserves by 2050

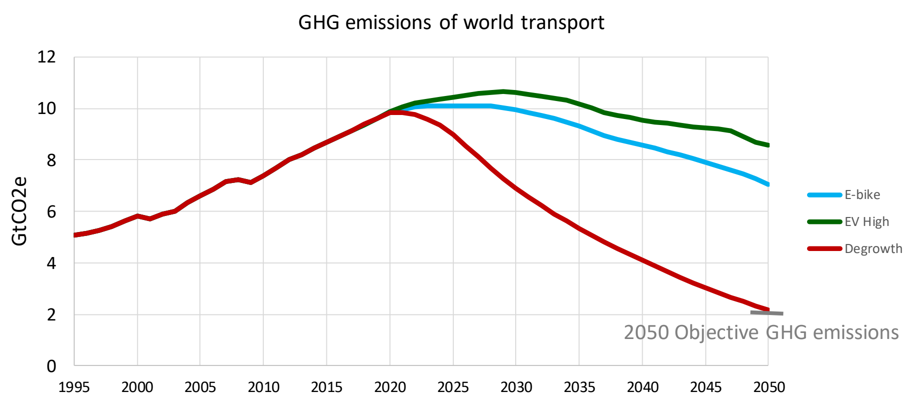
	EV High	E-bike
Aluminum in 2050 for EV batteries	2.75%	2.32%
Copper in 2050 for EV batteries	38.7%	28.0%
Lithium in 2050 for EV batteries	132.8%	38.9%
Manganese in 2050 for EV batteries	25.5%	9.72%

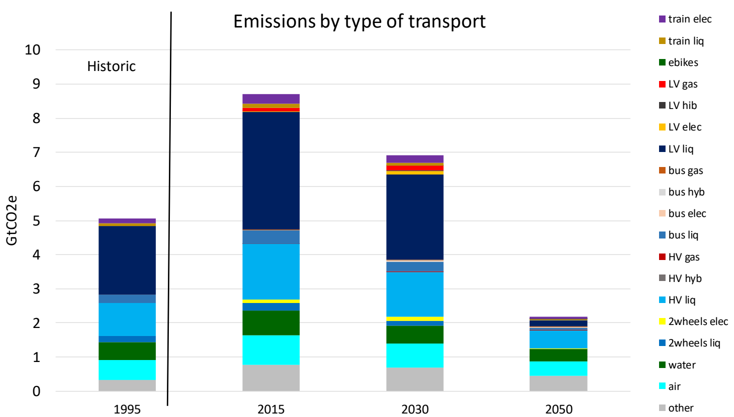
Navigating the future of electric vehicles

Achieving a high reduction in global transport emissions requires a scenario which involves a drastic reduction in demand for transport (especially air transport)

This requires not only much less flying but also:

- Tomorrow's society should be propelled mainly by bicycles and public transport
- Freight and long-distance travel should be mostly done on railways





Navigating the future of electric vehicles

Policy recommendations at EU level:

- Policies to promote widespread teleworking even after the pandemic.
- Make inner-city areas car-free zones.
- Invest heavily in public transport and car-sharing.
- Promote local trade.
- Modernize the railway network and improve the interconnections.
- Introduce an EU-wide ban of short-haul flights.
- Impose a kerosene tax on flying.

Five science-based tips for the EU's green transition

Tip 4: Avoiding the inequalities of green growth

LOCOMINAR: Five science-based tips for the EU's green transition

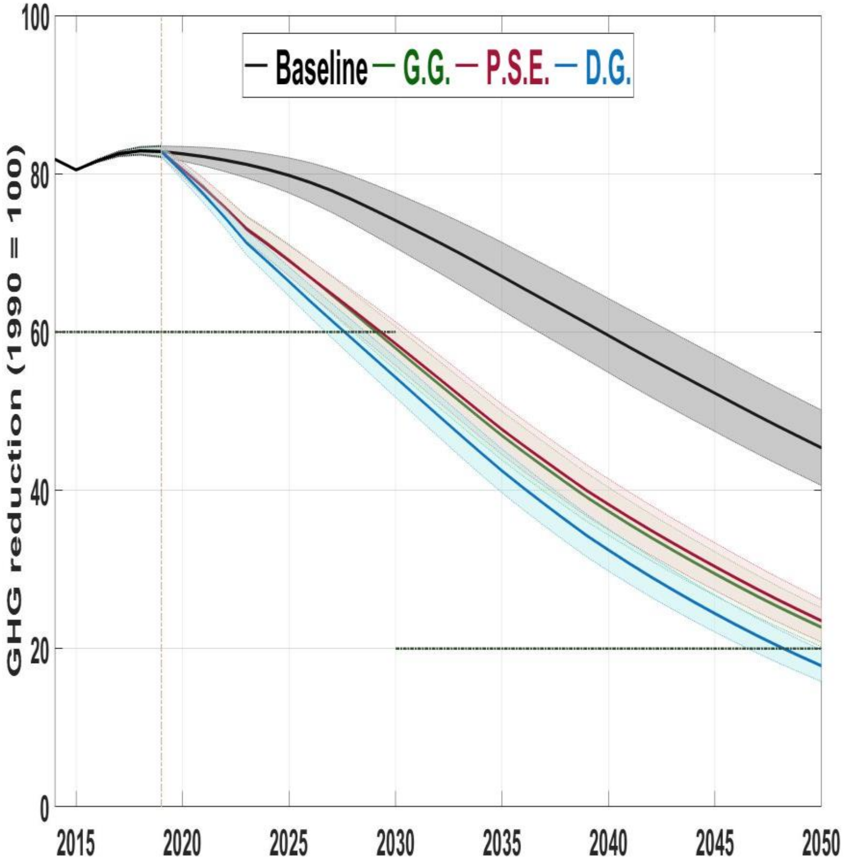
Tiziano Disfano (UNIPI)

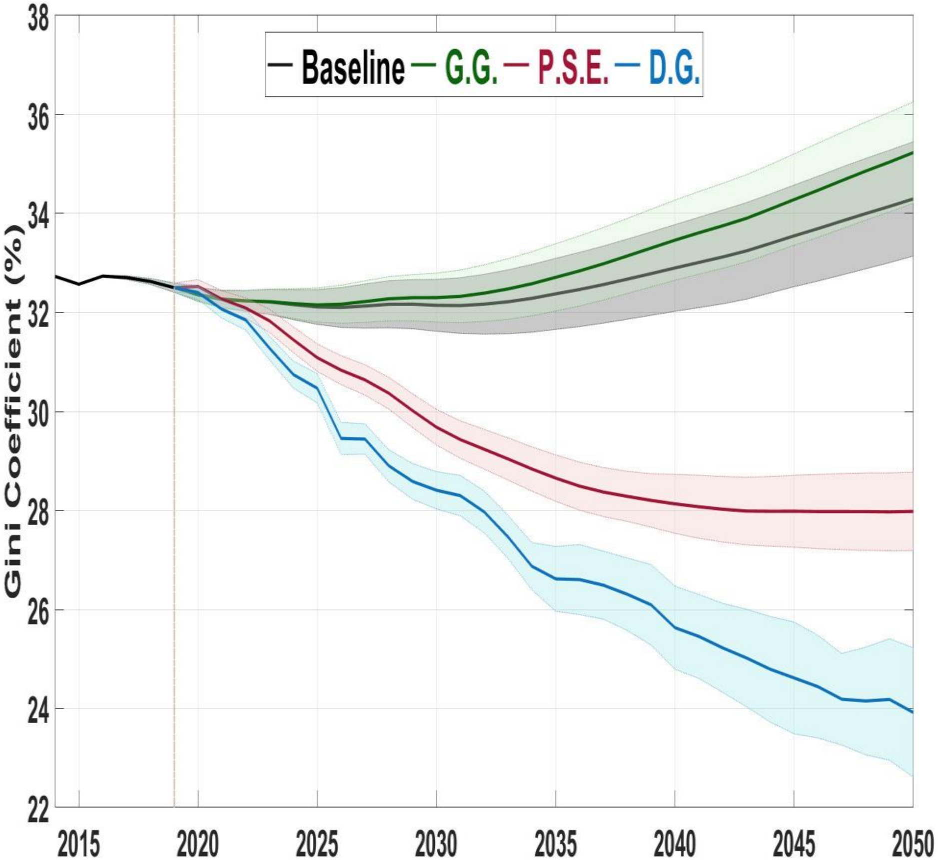
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 821105.

Green growth in a nutshell

- Green growth relates to energy policies and incentives for innovations that foster **labour productivity and energy efficiency**
- mainstream and institutional paradigm (SDGs, COP, etc.) focused on energy/environment and **techno-optimism**;
- market-oriented solutions: **trickle-down effect** should improve welfare and job creation;
- **limited compensation** policy for low-income and out-of-market activities (e.g., caring);
- **weak** theoretical and empirical **foundation**: no decoupling (Wiedman, 2015), planetary boundaries (O'Neill, 2018; Hickel and Kallis, 2019), critical transition (Scheffler, 2012), job destruction (Jaimovich, 2018)

Policy scenario results





D'Alessandro, S., Cieplinski, A., Distefano, T., & Dittmer, K. (2020). Feasible alternatives to green growth. Nature Sustainability, 3(4), 329-335.

Policy recommendations

Environmental policies alone fail to deliver the advocated improvements in employment and income distribution.

Feasible alternatives to green growth exist!

1. Expand and enlarge the EU's Just Transition Mechanism (JTM) to truly ensure that nobody is left behind by incorporating gender and other dimensions of exclusion and marginalisation
2. Complex decisions and trade-offs must involve social decisions to define the priorities based on a common consensus
3. Introduce innovative redistributive policies such as
   - universal basic income,
   - shorter working weeks,
   - job sharing,
   - job guarantee schemes
   - universal care incomes

Go and play!

France

Italy

RRI for policy design

inclusion | anticipation | transparency | responsiveness

Five science-based tips for the EU's green transition

Tip 5: Remove carbon removals

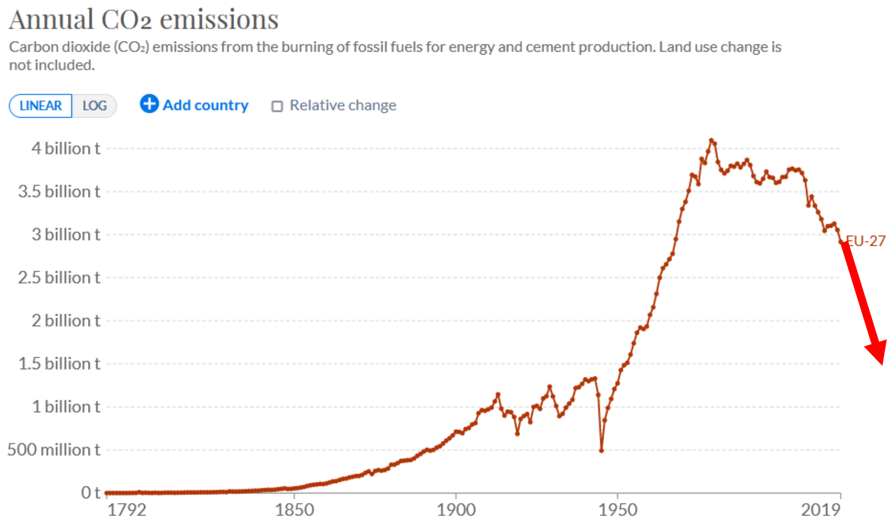
Friday the 22nd October

Margarita Mediavilla (UVa)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 821105.

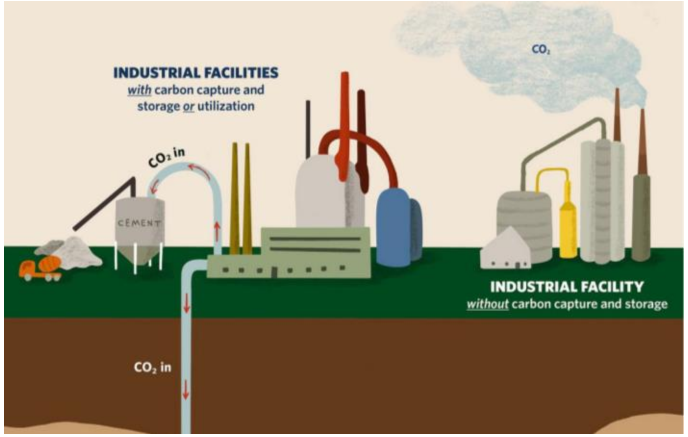
Remove carbon removals

- The proposed European Climate Law seeks to reduce carbon emissions by 55% by 2030 compared with levels in 1990. This is still less than the 65% scientists estimate is required to keep global warming to below 1.5⁰C.



Remove carbon removals

- Carbon capture and storage (CCS) remains part of the European Commission 2030 climate and energy policy framework. CCS relies on capturing CO2 as it is emitted and storing it underground.
- CCS technologies are still in their infancy and are often expensive to upscale from experimental projects or unproven at larger scales.



Energy costs of carbon removals

- Energy Return On Investment (EROI) = $\frac{Energy\ obtained}{Energy\ invested}$

fuel extraction+ power plant construction+operation + CCS building+decommissioning

	Coal	Coal+CCS	BioE	BioE+CCS
EROIst of energy source	46 (Hall et al., 2014)		2-3 (de Castro et al., 2014)	
EROIst of energy system	14.7	4.6	2.7 – 3.7	1.9 – 2.1
EROIpou of energy system (=EROIst-1)	13.7	3.6	1.7 – 2.7	0.9 – 1.1

Policy recommendations

- Carbon removal needs to be pursued as secondary and complementary to, not substitute for, emissions reductions.

- The limitations and uncertainties associated with carbon removal must be fully factored into our climate actions.

- EROI analysis is recommended before planning of infrastructures.

- BECCS competes with other uses of biomass and land.

- Carbon capture by biological means (reforestation, increase of soil carbon connect via regenerative techniques, agroforestry, etc.) is not subject to these limitations.

LOCOMOTION

Low-carbon society:
An enhanced modelling tool for the transition to sustainability

Margarita Mediavilla (University of Valladolid)

info@locomotion-h2020.eu

www.locomotion-h2020.eu

Follow us

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 821105.

Q and A

LOCOMOTION