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POINT Review of Industrial Transition of Greece

Renewables, Batteries and their Applications in Mobility, Agriculture, Shipping and Defence

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Abstract

Countries and regions around the world are gearing up to make the industrial transitions that will be necessary to move towards sustainable production and consumption patterns. This report documents the findings of a review of industrial transition of Greece launched in 2019 in partnership with the Greek Ministry of Development and Investments, which follows the POINT (Projecting Opportunities for INdustrial Transitions) methodology of the JRC. The review explores some of the policy pathways that Greece might take as it moves from a dependence on fossil fuels to an economy that makes greater use of renewable sources of energy and exploits many of the opportunities that are arising in the production and use of batteries in the realms of transport and mobility, agriculture, shipping and defence.

Sustainable energy and mobility will have a central role to play in maintaining (and restoring) Greece's exceptional endowment in natural capital, which is the foundation for tourism and agro-food – two pillars of a still fragile Greek economy. Greece has at least some of the prerequisites to develop relevant industrial capabilities, namely large investments in human capital that have been sustained over many years; an internationally outstanding science base; pockets of relevant production capabilities; a positive momentum in foreign direct investment in recent years (albeit starting from a very low level), alignment of consumer demand with the direction of the transition and unprecedented EU financial support for the transition.

Greece has innovation and production strengths in small, but dynamic production niches (notably parts of the value chains of renewables, batteries, small-scale shipbuilding and maintenance) operating within their respective internationally weak sectors. These strengths have high potential complementarities with sectors underpinning the deep transformation of the global energy system towards renewables and the looming transition towards electrification of mobility, including in shipping. The review shows that some Greek firms are active in developing applications in areas of major economic importance (on account the considerable size of the domestic market), including, among others, renewable energy generation and distribution, ICT and energy solutions for non-interconnected islands, and shipping.

In the absence of advance planning, however, there is no guarantee that a transition will lead to a diversified, knowledge-based and therefore tradable-intensive Greek economy, or that the benefits from the transition will be widely felt. Advance preparation, government leadership and wide stakeholder coordination, especially with the local communities that stand to gain or lose the most, are vital prerequisites. In view of the magnitude of the coordination challenge for national, regional and municipal policies and the narrowing window of opportunity, possible governance solutions may include a time-bound national mission ("a Greek Green Deal for Sustainable Industry and Quality Employment") coupled with regional or local "shared agendas" for transformation. Drawing from international practice, the review examines possible policies and candidate tools that could potentially link these currently disparate sectors into a vibrant industrial ecosystem, including market creation measures (e.g. legislation incl. measures for its enforcement, land use regulation, provision of public infrastructures); support for innovation; vocational skills, public private partnerships for investment; public transport, energy and defence procurement among many others.

Executive Summary EN

Countries and regions around the world are gearing up to make the industrial transitions that will be necessary to move towards sustainable production and consumption patterns. This report explores some of pathways that Greece might take as it moves from a dependence on fossil fuels to an economy that makes greater use of renewable sources of energy and exploits many of the opportunities that are arising in the production and use of batteries in the realms of transport and mobility, agriculture, shipping and defence.

The route followed in the production of this report involved:

- Extensive discussions with a broad range of public and private stakeholders to identify and validate the focus of the report on renewables, batteries and their applications in mobility, agriculture, shipping and defence;
- An articulation of the rationale for the proposed transition, based on stakeholder discussions and background research;
- A broad overview of the current state of the socio-economic system that is likely to be involved in, and impacted by, a transition, including a SWOT analysis of strengths, weaknesses, opportunities and threats;
- An outline of one possible future state, based on its desirability amongst key stakeholders and a pragmatic assessment of the SWOT analysis;
- Suggestions and recommendations concerning the steps needed to progress along potential pathways to this envisaged future.

The executive summary only presents the main, high-level, action-oriented findings, recommendations and implications for future policy. A more detailed summary of the report is included in Appendix 1.

There is a groundswell of support amongst key stakeholders in Greece for a managed industrial transition that attempts to realise the benefits associated with a greater emphasis on renewables, batteries (and other forms of energy storage) and their applications.

Greece has much to gain from a timely transition to more sustainable production and consumption. In particular, sustainable energy and mobility have a central role to play in maintaining (and restoring) Greece's exceptional endowment in natural capital, which is the foundation for tourism and agro-food – two pillars of a still fragile Greek economy. Greece's cities have perhaps the most to gain – the savings from foregone public health costs[1] alone could pay for an ambitious drive towards sustainable energy and mobility. Many of the health benefits derive directly from reductions in air pollution, which is particularly severe in the Athens metropolitan area, where over one third of the population lives. Above all, though, a transition presents an opportunity to take advantage of foreseeable tendencies in domestic demand and 'green' public investment, including historically unprecedented EU support, to facilitate the development of internationally tradable sectors and respond to the employment crisis afflicting Greece.

In the absence of advance planning, however, there is no guarantee that a transition will lead to a diversified, knowledge-based and therefore tradable-intensive Greek economy, or that the benefits from the transition will be widely felt. Advance preparation, government leadership and wide stakeholder coordination, especially with the local communities that stand to gain or lose the most, are vital prerequisites.

[1] The economic value of health benefits has been estimated to be twice as big as the cost of implementation of measures in keeping with the Paris Agreement. See: Markandya, A., Sampedro, J., Smith, S.J., Van Dingenen, R., Pizarro-Irizar, C., Arto, I., González-Eguino, M. (2018), "Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study", *The Lancet Planetary Health*, Vol. 2(3), E126-E133, https://doi.org/10.1016/S2542-5196(18)30029-9 .

A transition, besides having obvious benefits for the environment and human health, would present a unique opportunity for *industrial development* and the *creation of quality employment*.

Industrial development efforts are more effective when they are tailored to the needs of specific production and consumption systems. This requires context-specific intelligence about needs, responsiveness to stakeholder concerns, legal and regulatory certainty, and an ability to act decisively when rare windows of opportunity emerge. There are mounting indications that precisely such a rare window is currently open in renewable energy and sustainable transport, in what may be a once-in-a-century opportunity. Modelling projections of the global decarbonisation wave we are likely to experience in the decades ahead suggest transformational changes in the ways energy is produced and consumed. Moreover, the EU scene for exploiting this momentous opportunity for industrial development could not be more favourable. Greece stands to benefit from unprecedented amounts of EU funding linked to the European Green Deal and the EU Recovery Fund, most of which will be directly linked to the green (and digital) transitions. In terms of windfalls, the amounts involved are expected to be equivalent in magnitude to multiple EU structural funds packages arriving all at once. At the same time, the EU is developing a series of initiatives (such as the IPCEIs – Important Projects of Common European Interest) aiming for the accumulation of productive capabilities and the creation of new competitive advantages for Europe from the abovementioned transitions.

The global energy and transport transition coincides with a pressing need for Greece to diversify into economic sectors that are internationally tradable, environmentally sustainable and knowledge-intensive. It is especially important to provide *quality employment opportunities* to stem the pronounced emigration of the highly-skilled, a trend that accelerated following the decade-long financial crisis and has continued to undermine Greece's long-term future.

Greece has productive capabilities in narrow and unconnected niches within the energy and transport system, though they are embedded within industrial sectors that are weak in terms of international comparisons. While Greece does not currently have sufficient industrial capabilities to engage in large-scale experimentation and production, it is certainly possible to develop such capabilities over the long timeframe that any transition would involve. As detailed in this review, there are tantalising possibilities for the development of a vibrant industrial ecosystem in Greece, taking advantage in particular of foreseeable consumer tendencies towards the electrification of mobility and the democratisation of power generation. Greece's ten million plus inhabitants, eight hundred thousand businesses and five million vehicles require energy, a rapidly increasing proportion and eventually the majority of which, will be electricity, produced sustainably, locally, and be stored for some period in advance of its use. Even if the current production system in Greece is unable to meet these future needs, supply does eventually follow demand, with the implication that at least some of these goods and associated services will be produced in Greece. If the conditions are right, these could then become a springboard for insertion into global value chains and broader industrial development.

However, the planning and coordination effort required is colossal and is unlikely to succeed within the current framing of Greek industrial policy.

Greece has at least some of the prerequisites to develop relevant industrial capabilities, namely large investments in human capital that have been sustained over many years; an internationally outstanding science base; pockets of relevant production capabilities; a positive momentum in foreign direct investment in recent years (albeit starting from a very low level), alignment of consumer demand with the direction of the transition and unprecedented EU financial support for the transition. Advance preparation, and wide stakeholder coordination, including liaison with the local communities that stand to gain or lose the most, are necessary but not sufficient conditions. *Realising the economic promise of the transition will require a colossal mobilisation effort, which unfortunately seems unlikely to happen within the current framing of industrial policy in Greece*. The key challenge in this respect is to secure the primacy of an industrial development logic ahead of all other logics of intervention. The urgency of this challenge is great when confronted with the employment crisis afflicting Greece,

which will likely worsen due to the pandemic. An industrial development logic, however, is needed to spearhead the response to these multiple challenges.

The colossal coordination challenge calls for a National Mission: a 'Greek Green Deal for Sustainable Industry and Quality Employment'.

Given the high stakes for Greece, the narrowing window of opportunity and the immense coordination task ahead, an appropriate response could be the launch of a national mission for sustainable industrial development and the creation of quality employment: a 'Greek Green Deal for Sustainable Industry and Quality Employment'. The chief advantages of a national mission are that it could engage stakeholders and align efforts by setting a clear direction; raising the degree of ambition; providing long-term certainty; uniting complementary actions across government under its umbrella; and promoting direct accountability about outcomes to the highest political level (e.g. the Prime Minister's Office).

Inspiration for the drafting of a concrete mission statement appropriate for a 'Greek Green Deal for Sustainable Industry and Quality Employment' could be sought in the clear, ambitious and time-bound goals that can be found in the National Energy and Climate Plan (NECP) as well as the implications for indigenous industry and employment arising from the Greek "Green Pact for Electric Mobility[2]". To achieve prioritised mission goals, it will be necessary to change the way in which industrial policy is framed, graduating beyond independent support for research and innovation activities (which need to be further strengthened anyway) and disassociated sector-agnostic investment, and towards a mission-driven transition agenda that needs to be much more holistic in nature, connecting parts of the policy system that have traditionally operated in a largely autonomous fashion. Industrial policy will need to extend beyond research and innovation policy and encompass the full panoply of policy tools used to support business investment and leverage all relevant resources, including the spending budgets of households, businesses and government.

In this new framing, the implicit competition for resources between the policy objectives of environmental protection, a cohesive society and economic growth can be neutralised. Instead of competition, synergies should be promoted by exploring, discovering and promoting those pathways that use the same resources to achieve all three: The imperative for Greece is environmentally sustainable industrial development *that also* generates broad-based quality employment *and* allows Greece to thrive in knowledge-intensive tradable sectors.

Consider launching a national mission on energy and mobility transition in which local industrial development and the creation of high-quality employment are the central objectives. This can build and extend upon the recently launched Greek Green Pact for Electric Mobility. Couple the mission with additional mechanisms enabling coordination within government and broad stakeholder cooperation.

A national mission can help accomplish the challenge of elevating industrial development and employment into a major national objective, if it attains the backing of all social stakeholders and acts as a meta-strategy for government action between and across ministries, regions and cities. To turn the mission into a national project that lasts longer than any one administration, it would have to secure political commitment and backing from all sides in parliament.

A clear direction for policy focused on industrial development that is environmentally sustainable, socially just and knowledge-intensive could transform individual policy portfolios that currently compete for attention and resources (i.e. environment, employment and social protection, business support, research and innovation, energy and transport infrastructures) into a formidable alliance for change. If the actions of the government bodies responsible for these portfolios were then to be scrutinised and evaluated under the prism of this directionality, the natural incentive would be to evolve allied policy portfolios that combine resources where possible and actively seek synergies capable of amplifying the impact of individual interventions in multiple domains.

[2] https://energypress.gr/news/20-foreis-ypegrapsan-tin-prasini-symfonia-gia-tin-proothisi-tis-ilektrokinisis-olokliro-keimeno

By reporting directly to the Prime Minister, a mission would improve accountability but would not, by itself, enable smooth coordination across government ministries and different levels of governance. Additional coordination mechanisms will be needed to promote holistic planning and ensure effective implementation. These include a greater role for 'smart' intermediate committees and working groups, capable of maximising coordination and communication and minimising bureaucratic overload; an important implementation role for cities (who combine several policy domains and are closer to citizens); and the parallel development of localised roadmaps and shared agendas. The latter could build on recent experience with participatory governance in the context of the development of smart specialisation strategies (e.g. using Entrepreneurial Discovery Process workshops) but should have a broader transition remit.

Coordination issues are not the sole preserve of government. It is especially striking in comparison to other EU countries that businesses of the broad sector do not explore positive sum outcomes. The absence of industry initiatives capable of exploring, identifying and representing the collective interests of an extremely diverse sector, which spans firms of all sizes and a wide variety of technologies, is worrying in its own right. This will have to be tackled as part of wider efforts to construct an effective system of stakeholder engagement.

Design policies whose purpose is the *creation of new markets* that can help drive and pay for the transition in the long-term. The most urgent intervention in this regard is the introduction of concrete measures to enforce environmental legislation, a step that would deter free riders and boost sustainability across industry.

Some of the markets that can drive the transition do not yet exist, and will take creativity and forward-looking government policy to support their creation. Market creation measures include the provision of legislation concerning the deployment and use of new technologies; the introduction of land use regulation (covering, for example, small scale pumped hydro and industrial waste management and recycling); measures designed to encourage investment, increase appropriability and thus raise returns to investments; the strategic use of public procurement to stimulate new markets; and support for the provision of public infrastructures (e.g. an upgraded grid, EV charging and hydrogen refuelling facilities).

The strategic provision of public infrastructure based on an industrial development logic could achieve a great deal. Financed either directly by public funds or in collaboration with industry (e.g. using Public Private Partnerships), some infrastructure needs stand out as particularly important. These include updated and extended transmission and distribution networks, mass transit, electrified vehicle charging infrastructure (including provision for seaports), battery recycling infrastructure and smart grids.

An additional market-creation measure especially beneficial to innovative SMEs would be the creation of regulatory sandboxes. Sandboxes are protected and supervised spaces where conditional exemptions from regulations currently in force allow rapid experimentation, learning and innovation. However, the introduction of regulatory sandboxes would only be prudent if the energy regulator, and possibly ancillary regulators, such as those regulating the use of personal data and telecommunications, could upgrade their governance capacities while safeguarding their independence.

Sequence interventions that leverage consumer demand for industrial development and facilitate cooperation that results in system-level innovation.

As part of the national mission, it will be important to prepare and publish in advance a long-term roadmap of public support for the transition that demonstrates an appropriate and effective *sequencing* of policy interventions. Consider, for example, offering support for national industrial expansion (including support for joint ventures with globally leading producers and other measures facilitating FDI) in those product areas and services that are needed by households to transition, but doing this *before* (or at least in parallel to) subsidising household investments in energy efficiency, household RES and storage, and electrified mobility solutions.

Many other changes to the industrial system can be realised by industry and stakeholders themselves, yet the government still has to play a crucial role as an orchestrator of collaborations. One of the most interesting ideas to emerge in discussions with stakeholders was the potential conversion of RES energy ledgers in the islands to utility ledgers using distributed ledger technology. In practice, this would allow households and businesses in the islands that produce their own energy to exchange surpluses they do not use for the utility services they do need, such as water, waste collection or sanitation (the processing of which requires energy). Such a system-level innovation would, at a single stroke, encourage household and business investments in renewables and increase the rate of return for investments in energy-intensive desalination plants and household waste management facilities.

Offer compelling future pathways to those regions (such as Western Macedonia and Megalopolis) and social groups (such as workers in fossil fuel industries) that stand to lose the most during the transition unless feasible alternatives are pursued. The unprecedented EU resources to support their transition open up new possibilities which must, however, be rigorously governed.

For example, it is worth exploring the possibility of transforming Western Macedonia into an internationally renowned knowledge producer and demonstrator region for *environmental remediation*. The heavy environmental legacy of phased out mining and coal burning activities in fact presents exactly the kind of challenge out of which unique production strengths can emerge. Solving Western Macedonia's environmental problems could hold the solution to its employment and social problems too, if the unprecedented opportunity of EU support – in the form of the Just Transition Fund and the Recovery and Resilience plans - is firmly grasped and deployed effectively. Overcoming the challenges posed by mine reclamation and water and land restoration could result in a host of associated environmental remediation technologies, demand for which can be reasonably expected to rise as the global community seeks to address the climate emergency.

The transition also provides an occasion to reform and expand Greece's stunted Vocational Education and Training (VET) system. Besides facilitating industrial development, a better performing VET system would offer opportunities for lower income workers, who currently have too few paths to develop their skills. In this respect, Greece would benefit particularly from the recent EU initiative on Centres for Vocational Excellence (COVEs). Participation in the COVEs initiative would provide precisely the needed impetus and direction to upgrade and link VET to both current and prospective market needs. To begin with, COVEs could help establish a small number of pioneering centres of vocational education, with a view to scaling them up to offer nationwide coverage at a later date.

Closely monitor prices in energy, energy storage and sustainable (electrified) mobility and examine policies that raise the rate of return for investors and improve affordability for consumers.

The promotion of competitive pricing will be key to reaping the opportunities for energy price reductions that are presented by the accelerated deployment of RES. The future of energy-intensive industry in Greece – currently confined to cement, bauxite and nickel production – crucially hinges on the contribution of RES to reductions in what are currently exceptionally high wholesale energy prices. For RES to make a lasting contribution to energy price reduction, a clear path for investments in energy storage is necessary. Greek policy makers should accelerate their planning for a national strategy for energy storage, which should include provisions for industrial development and the creation of quality employment.

In the future, as the transition advances and energy costs fall, Greece is likely to become an important producer of renewable energy in South Eastern Europe. It will be important to use energy surpluses in ways that also contribute to further industrial development. For example, the occasion of decisive drops in energy costs could be used to introduce other policies that, taken together, encourage investments in energy-intensive industries. These may take different forms in various application niches, e.g. in large-scale manufacturing (e.g. hydrogen electrolysis, recycling); in cities (e.g. energy

communities, EVs, mass transport, waste management); and in the islands (e.g. desalination plants, electrified/hydrogen shipping).

Finally, this report is only a starting point. It should be seen as a call to action and a catalyst of intensified efforts to plan and realise a sustainable future for Greece that also leads to increased prosperity and greater social cohesion.

The list of actions that follows includes the first steps towards implementing the abovementioned recommendations:

What?	Who?	When?
Consider the development and adoption of a time-bound and ambitious national mission for sustainable industrial development and quality employment. Devise a suitable governance and monitoring structure that allows for the coupling of technological and socio-economic developments that could shape a coherent transition path.	**Prime Minister's Office (General Secretariat of Coordination)** **Ministry of Development and Investment** Ministry of Digital Governance Ministry of Interior All other Ministries as necessary Regions Municipalities	2021
Accompany existing and future support measures for the promotion of sustainability among households (c.f. Εξοικονομώ-Αυτονομώ, subsidies for electric mobility), with investment measures that support the productive capability of domestic industry to offer an increasing share of these solutions, with a particular focus on business innovation.	**Ministry of Development and Investment** Ministry of Environment and Energy	2021-2028
Bring together research, business, government and citizen representatives to develop place-based shared agendas on renewables (including investments by households), mobility solutions and mobility systems.	**Ministry of Infrastructure and Transport** Ministry of Environment and Energy Regions Municipalities	2021-2024
Extend Lifelong Learning Centres to regional field labs, combining vocational training with public-private innovation	**Ministry of Education** Ministry of Employment	2021

and demonstration activities. Encourage active participation of Greek stakeholders to European Centres for Vocational Excellence (COVEs).		
Enhance capacity to enforce environmental legislation (e.g. by hiring additional inspectors) in order to level the playing field for sustainable business practices.	**Ministry of Environment and Energy** Ministry of Justice Regions	2021
Accelerate the introduction of special investment stimuli in affected regions (Western Macedonia and Megalopolis) and the necessary changes in spatial planning. Consider the feasibility of a flagship project on environmental remediation in Western Macedonia, with the combined target of restoring the natural environment, developing productive capabilities and innovation capabilities.	**Ministry of Development and Investment** **Ministry of Environment and Energy** Region of Western Macedonia Region of Peloponesse	2021
Facilitate joint ventures with globally leading producers of renewable energy technologies through FDI and channel these investments into affected regions (Western Macedonia and Megalopolis).	**Ministry of Development and Investment** Ministry of Finance	2021-23
Support the transformation of 10-20 small, non-interconnected islands to energy- and water-autonomous, RES powered islands.	**Ministry of Environment and Energy** Ministry of Maritime Shipping and Island Policy	2022-26
Stimulate the gradual replacement of fossil fuel in short-haul shipping and develop related port facilities.	**Ministry of Maritime Shipping and Island Policy** Ministry of Development and Investment	2023-26
Introduce strong incentives for investments in RES-generation and storage to complement existing energy efficiency schemes for buildings. Accelerate the preparation of a national strategy on energy storage, which must contain measures for accompanying	**Ministry of Environment and Energy** Ministry of Development and Investment	2022-2026

industrial development and the creation of quality employment.		
Prioritise public procurement of innovation (e.g. by setting a goal like 2.5% of public expenditures), assign necessary resources and develop capacity to act within pubic administrations.	**Ministry of Development and Investment** Ministry of Finance	2022
Seek active participation of Greece in EU initiatives to strengthen industrial capabilities in this domain, including the European battery alliance, the Hydrogen alliance, IPCEIs (including microelectronics), and develop cross-border partnerships in areas of common interest (e.g. with neighbouring Bulgaria and Italy).	**Ministry of Development** (General Secretariat of Industry, General Secretariat of Research and Technology, General Secretarial on Structural Funds) Ministry of Environment and Energy Regions	2021-22
Spur ecosystem development by investing in knowledge transfer mechanisms (e.g. via KTOs and incubators).	**Ministry of Development and Investment** Ministry of Education	2021-2028

Executive Summary- EL
ΕΠΙΤΕΛΙΚΗ ΣΥΝΟΨΗ

ΕΠΙΣΚΟΠΗΣΗ ΤΗΣ ΒΙΟΜΗΧΑΝΙΚΗΣ ΜΕΤΑΒΑΣΗΣ ΤΗΣ ΕΛΛΑΔΑΣ ΣΤΙΣ ΑΝΑΝΕΩΣΙΜΕΣ ΠΗΓΕΣ ΕΝΕΡΓΕΙΑΣ (ΑΠΕ), ΤΙΣ ΜΠΑΤΑΡΙΕΣ ΚΑΙ ΤΩΝ ΕΦΑΡΜΟΓΩΝ ΤΟΥΣ ΣΤΟΥΣ ΤΟΜΕΙΣ ΤΗΣ ΚΙΝΗΤΙΚΟΤΗΤΑΣ, ΓΕΩΡΓΙΑΣ, ΝΑΥΤΙΛΙΑΣ ΚΑΙ ΑΜΥΝΑΣ.

Χώρες και περιφέρειες σε όλο τον κόσμο προετοιμάζονται για να κάνουν τις βιομηχανικές μεταβάσεις προς βιώσιμα πρότυπα παραγωγής και κατανάλωσης. Αυτή η έκθεση διερευνά ορισμένες από τις κατευθύνσεις που μπορεί να ακολουθήσει η Ελλάδα καθώς μεταβαίνει από την εξάρτηση από τα ορυκτά καύσιμα σε μια οικονομία που κάνει μεγαλύτερη χρήση ανανεώσιμων πηγών ενέργειας (ΑΠΕ) και εκμεταλλεύεται πολλές από τις ευκαιρίες που προκύπτουν από την παραγωγή και χρήση ΑΠΕ και μπαταριών στους τομείς της κινητικότητας, γεωργίας, ναυτιλίας και άμυνας.

Η διαδρομή που ακολουθήθηκε[3] κατά την σύνταξη αυτής της έκθεσης περιελάμβανε:

- Εκτεταμένες συζητήσεις με ένα ευρύ φάσμα δημόσιων και ιδιωτικών φορέων για τον προσδιορισμό και την επικύρωση της θεματικής εστίασης της έκθεσης στις ΑΠΕ, τις μπαταρίες και τις εφαρμογές τους στην κινητικότητα, τη γεωργία, τη ναυτιλία και την άμυνα.
- Τη διαμόρφωση της συλλογιστικής και των επιχειρημάτων για την προτεινόμενη μετάβαση, έπειτα από διαβούλευση των ενδιαφερόμενων μερών και εκτεταμένη έρευνα.
- Μια ευρεία επισκόπηση της τρέχουσας κατάστασης του κοινωνικοοικονομικού συστήματος που είναι πιθανό να εμπλακεί και να επηρεαστεί από μια μετάβαση, συμπεριλαμβανομένης μιας ανάλυσης SWOT για τα δυνατά σημεία, τις αδυναμίες, τις ευκαιρίες και τις απειλές.
- Το περίγραμμα μιας πιθανής μελλοντικής κατάστασης, βάσει των δηλωμένων επιθυμιών των βασικών εμπλεκόμενων φορέων και μιας ρεαλιστικής αξιολόγησης της ανάλυσης SWOT.
- Προτάσεις και συστάσεις σχετικές με τα βήματα που απαιτούνται για την πρόοδο σε πιθανές διαδρομές προς αυτό το επιθυμητό μέλλον.

Η παρούσα περίληψη παρουσιάζει μόνο τα κύρια ευρήματα, προσαρμοσμένα σε μορφή συστάσεων για άμεσες δράσεις πολιτικής και για το μελλοντικό σχεδιασμό πολιτικής.

Υπάρχει ισχυρή υποστήριξη μεταξύ των κύριων ενδιαφερομένων μερών στην Ελλάδα για τη διαχείριση της βιομηχανικής μετάβασης που επιχειρεί να εκμεταλλευτεί τα οικονομικά και κοινωνικά οφέλη από τη στροφή στις ανανεώσιμες πηγές ενέργειας, τις μπαταρίες (και άλλες μορφές αποθήκευσης ενέργειας) και τις εφαρμογές τους.

Η Ελλάδα θα μπορούσε να αποκομίσει πολλαπλά οφέλη από την έγκαιρη μετάβαση σε πιο βιώσιμη παραγωγή και κατανάλωση. Ειδικά η αειφόρος ενέργεια και η βιώσιμη κινητικότητα θα έχουν κεντρικό ρόλο στη διατήρηση (και την αποκατάσταση) του μοναδικού περιβαλλοντικού κεφαλαίου της Ελλάδας, που άλλωστε αποτελεί και το ανταγωνιστικό θεμέλιο για τους κλάδους του τουρισμού και της αγροδιατροφής – οι οποίοι είναι αυτή τη στιγμή οι πυλώνες μιας ακόμα εύθραυστης ελληνικής οικονομίας. Οι πόλεις της Ελλάδας θα μπορούσαν να βγουν ιδιαίτερα κερδισμένες. Είναι χαρακτηριστικό ότι βάσει υπολογισμών[4], μόνο η εξοικονόμηση του κόστους που προκαλεί η

[3] Για την σύνταξη της έκθεσης ακολουθήθηκε η μεθοδολογία POINT (Projecting Opportunities for INdustrial Transitions / Προβολή Ευκαιριών για Βιομηχανικές Μεταβάσεις) που συνδυάζει έννοιες και διεθνείς εμπειρίες από τις βιβλιογραφίες των λεγόμενων νέων βιομηχανικών πολιτικών (new industrial policies) και της διακυβέρνησης συστημικής ή μετασχηματιστικής καινοτομίας (system innovation, transformative innovation policy). Η μεθοδολογία αναπτύχθηκε από το Κοινό Κέντρο Ερευνών της Ευρωπαϊκής Επιτροπής στα πλαίσια της ομάδας εργασίας για την Κατανόηση και Διαχείριση Βιομηχανικών Μεταβάσεων. Για περισσότερες πληροφορίες και το πλήρες κείμενο της μεθοδολογίας βλ.: https://s3platform.jrc.ec.europa.eu/industrial-transition

[4] Συγκεκριμένα, η οικονομική αξία από τα οφέλη για τη δημόσια υγεία έχει υπολογιστεί ότι είναι διπλάσια από το κόστος υλοποίησης μέτρων που συνάδουν με την Συμφωνία του Παρισιού για την Κλιματική Αλλαγή: Markandya, A., Sampedro, J., Smith, S.J., Van Dingenen, R., Pizarro-Irizar, C., Arto, I., González-Eguino, M. (2018), "Health co-benefits from air pollution and mitigation costs of the Paris Agreement: a modelling study", *The Lancet Planetary Health*, Vol. 2(3), E126-E133, https://doi.org/10.1016/S2542-5196(18)30029-9 .

ρύπανση στην ευρύτερη δημόσια υγεία υπερβαίνει τις χρηματοδοτικές ανάγκες μιας φιλόδοξης μετάβασης. Πολλά από τα οφέλη για την υγεία προέρχονται άμεσα από τη μείωση της ατμοσφαιρικής ρύπανσης, η οποία είναι ιδιαίτερα σοβαρή στη μητροπολιτική περιοχή της Αθήνας, όπου ζει πάνω από το ένα τρίτο του πληθυσμού. Πάνω απ' όλα, ωστόσο, η μετάβαση παρέχει την ευκαιρία να εκμεταλλευτούμε τις διαφαινόμενες τάσεις στην εγχώρια ζήτηση (όπως η ηλεκτροκίνηση) και τις «πράσινες» δημόσιες επενδύσεις, συμπεριλαμβανομένης της προβλεπόμενης στήριξης της Ευρωπαϊκής Ένωσης (ΕΕ) για τον σκοπό αυτό σε κλίμακα άνευ ιστορικού προηγουμένου, για τη διευκόλυνση της ανάπτυξης διεθνώς εμπορεύσιμων οικονομικών τομέων και την αντιμετώπιση της κρίσης απασχόλησης που πλήττει την Ελλάδα.

Ωστόσο, χωρίς κατάλληλη προετοιμασία, δεν υπάρχει καμία εγγύηση ότι η μετάβαση θα οδηγήσει σε μια κλαδικά διαφοροποιημένη, βασισμένη στη γνώση και επομένως εξωστρεφή ελληνική οικονομία, ή ότι τα οφέλη από τη μετάβαση θα γίνουν ευρέως αισθητά. Βασικές προϋποθέσεις για την εκμετάλλευση των ευκαιριών είναι η εκ των προτέρων προετοιμασία, ο ηγετικός ρόλος της κυβέρνησης και ο συντονισμός δράσεων ανάμεσα σε ένα ευρύ φάσμα φορέων, ιδιαίτερα μάλιστα με τις τοπικές κοινότητες που απειλούνται και που δύνανται να επωφεληθούν από τη σωστή διαχείριση της μετάβασης.

Μια μετάβαση, εκτός από τα προφανή οφέλη για το περιβάλλον και την ανθρώπινη υγεία, θα αποτελούσε μια μοναδική ευκαιρία για *βιομηχανική ανάπτυξη* και *δημιουργία ποιοτικής απασχόλησης*.

Οι προσπάθειες βιομηχανικής ανάπτυξης είναι πιο αποτελεσματικές όταν είναι προσαρμοσμένες στις ανάγκες συγκεκριμένων συστημάτων παραγωγής και κατανάλωσης. Η ευόδωση προσπαθειών βιομηχανικής ανάπτυξης απαιτεί λεπτομερή γνώση των αναγκών του κλάδου, ανταπόκριση στις ανησυχίες των εμπλεκόμενων, νομική και θεσμική σταθερότητα και την ικανότητα αποφασιστικής δράσης όταν ανοίγονται παράθυρα ευκαιριών. Υπάρχουν αυξανόμενες ενδείξεις ότι ακριβώς ένα τέτοιο σπάνιο παράθυρο είναι προς το παρόν ανοιχτό ως προς τις ανανεώσιμες πηγές ενέργειας και τις βιώσιμες μεταφορές, ένα άνοιγμα που είναι ίσως μοναδικό τον τελευταίο αιώνα. Ποσοτικά μοντέλα για τις επιπτώσεις του παγκόσμιου κύματος περιορισμού των εκπομπών άνθρακα, προβλέπουν μετασχηματιστικές αλλαγές στον τρόπο παραγωγής και κατανάλωσης ενέργειας. Επιπλέον, το Ευρωπαϊκό τοπίο δεν θα μπορούσε να είναι πιο ευνοϊκό για την εκμετάλλευση αυτής της σημαντικής ευκαιρίας για βιομηχανική ανάπτυξη. Η Ελλάδα θα επωφεληθεί από πρωτοφανή ποσά χρηματοδότησης από την ΕΕ που συνδέονται με το Ευρωπαϊκό Πράσινο Σύμφωνο και το Ταμείο Ανάκαμψης της ΕΕ, τα περισσότερα από τα οποία θα συνδέονται άμεσα με την προβλεπόμενη πράσινη (και ψηφιακή) μετάβαση. Όσον αφορά το μέγεθος τους, τα σχετικά ποσά αναμένεται να είναι ισοδύναμα σε μέγεθος με αυτά πολλών προγραμμάτων διαρθρωτικών ταμείων ταυτόχρονα. Παράλληλα, η ΕΕ αναπτύσσει μια σειρά από πρωτοβουλίες (όπως λ.χ. τα IPCEI – Σημαντικά Έργα για το Κοινό Ευρωπαϊκό Συμφέρον) που έχουν ως σκοπό την συσσώρευση παραγωγικών δεξιοτήτων και την δημιουργία νέων οικονομικών πλεονεκτημάτων για την Ευρώπη από τις προαναφερθείσες μεταβάσεις.

Η παγκόσμια μετάβαση στην ενέργεια και τις μεταφορές συμπίπτει με την πλέον επιτακτική ανάγκη για την Ελλάδα να διαφοροποιήσει την οικονομία της και να αναπτύξει οικονομικούς τομείς με προϊόντα και υπηρεσίες εντάσεως γνώσης που είναι διεθνώς εμπορεύσιμα και περιβαλλοντικά βιώσιμα. Είναι ιδιαίτερα σημαντικό να δημιουργηθούν *ποιοτικές ευκαιρίες απασχόλησης* για την αναχαίτιση της έντονης μετανάστευσης του υψηλά καταρτισμένου ανθρώπινου δυναμικού, μια τάση που επιταχύνθηκε κατά τη δεκαετία της χρηματοπιστωτικής κρίσης και συνεχίζει να υπονομεύει το μακροπρόθεσμο μέλλον της χώρας.

Η Ελλάδα έχει ήδη παραγωγικές δυνατότητες σε εξειδικευμένους και μη συνδεδεμένους τομείς εντός του συστήματος ενέργειας και μεταφορών, οι οποίοι όμως είναι ενσωματωμένοι σε ευρύτερους εγχώριους βιομηχανικούς κλάδους που δεν έχουν ισχυρή διεθνή θέση. Ενώ η Ελλάδα δεν διαθέτει επί του παρόντος επαρκείς βιομηχανικές ικανότητες για να συμμετάσχει σε πειραματισμούς και παραγωγή μεγάλης κλίμακας, είναι σίγουρα εφικτό να αναπτυχθούν τέτοιες ικανότητες κατά τη διάρκεια του μεγάλου χρονικού διαστήματος που θα απαιτούσε οποιαδήποτε μετάβαση. Όπως περιγράφεται λεπτομερώς σε αυτήν την επισκόπηση, υπάρχουν εντυπωσιακές δυνατότητες για την ανάπτυξη ενός δυναμικού βιομηχανικού οικοσυστήματος στην

Ελλάδα, αν η χώρα εκμεταλλευτεί ιδίως τις διαφαινόμενες τάσεις των καταναλωτών προς την ηλεκτροκίνηση και τον εκδημοκρατισμό της παραγωγής ηλεκτρικής ενέργειας. Οι πάνω από δέκα εκατομμύρια κάτοικοι της χώρας, οι οκτακόσιες χιλιάδες επιχειρήσεις της και τα πέντε εκατομμύρια οχήματα χρειάζονται ενέργεια, όλο και μεγαλύτερο μέρος της οποίας θα είναι ηλεκτρική, θα παράγεται βιώσιμα και τοπικά, και θα αποθηκεύεται για κάποιο χρονικό διάστημα πριν από τη χρήση της. Ακόμα κι αν το υφιστάμενο σύστημα παραγωγής στην Ελλάδα δεν είναι σε θέση να καλύψει αυτές τις μελλοντικές ανάγκες, η προσφορά θα ακολουθήσει τελικά τη ζήτηση. Όπως γίνεται άλλωστε και τώρα, τουλάχιστον ορισμένα από αυτά τα αγαθά και οι συναφείς υπηρεσίες θα παραχθούν εγχώρια. Εάν οι συνθήκες είναι πρόσφορες, θα μπορούσε η μετάβαση να αποτελέσει εφαλτήριο για την είσοδο σε παγκόσμιες αλυσίδες αξίας και ευρύτερη βιομηχανική ανάπτυξη.

Ωστόσο, η απαιτούμενη προσπάθεια προγραμματισμού και συντονισμού είναι κολοσσιαία και είναι απίθανο να επιτευχθεί μέσα στο υπάρχον πλαίσιο βιομηχανικής πολιτικής της Ελλάδας.

Η Ελλάδα πληροί τουλάχιστον μερικές από τις προϋποθέσεις για την ανάπτυξη σχετικών βιομηχανικών δυνατοτήτων, όπως υπολογίσιμες και μακροχρόνιες επενδύσεις σε ανθρώπινο κεφάλαιο, διεθνώς εξαιρετικό επιστημονικό υπόβαθρο, θύλακες σχετικών παραγωγικών δυνατοτήτων, ανοδική τάση στις άμεσες ξένες επενδύσεις τα τελευταία χρόνια (αν και ξεκινά από πολύ χαμηλό επίπεδο), ευθυγράμμισή της καταναλωτικής ζήτησης με την κατεύθυνση της μετάβασης και άνευ προηγουμένου χρηματοδοτική στήριξη της ΕΕ για τη μετάβαση. Η σωστή προετοιμασία και ο συντονισμός των εμπλεκόμενων φορέων, συμπεριλαμβανομένης της διαβούλευσης με τις τοπικές κοινότητες που απειλούνται και που δύνανται να επωφεληθούν, είναι απαραίτητες αλλά όχι επαρκείς προϋποθέσεις. *Η εκμετάλλευση των οικονομικών οφελών της μετάβασης θα απαιτήσει μια κολοσσιαία προσπάθεια έγκαιρης κινητοποίησης, η οποία δυστυχώς φαίνεται απίθανο να συμβεί μέσα στο υπάρχον πλαίσιο βιομηχανικής πολιτικής της χώρας.* Η βασική πρόκληση από αυτή την άποψη είναι να διασφαλιστεί η επικράτηση της λογικής της παρέμβασης υπέρ του στόχου της βιομηχανικής ανάπτυξης έναντι όλων των άλλων λογικών παρέμβασης των εμπλεκόμενων χαρτοφυλακίων πολιτικής. Η ανάγκη αντιμετώπισης αυτής της πρόκλησης είναι επείγουσα, ιδιαίτερα λόγω της κρίσης απασχόλησης που πλήττει τη χώρα, η οποία πιθανότατα θα επιδεινωθεί λόγω της πανδημίας. Η πρωτοκαθεδρία της λογικής της βιομηχανικής ανάπτυξης είναι απαραίτητο να προηγηθεί της απόκρισης σε αυτές τις πολλαπλές προκλήσεις.

Η κολοσσιαία πρόκληση συντονισμού θα μπορούσε να αντιμετωπιστεί με την θέσπιση μιας εθνικής αποστολής: μια «Ελληνική Πράσινη Συμφωνία για Βιώσιμη Βιομηχανία και Ποιοτική Απασχόληση».

Δεδομένων των υψηλών διακυβευμάτων για την Ελλάδα, των χρονικά στενών πλαισίων για την εκμετάλλευση των ευκαιριών και της τεράστιας απαιτούμενης προσπάθειας έγκαιρου συντονισμού, μια κατάλληλη απάντηση θα μπορούσε να είναι η θέσπιση μιας εθνικής αποστολής για βιώσιμη βιομηχανική ανάπτυξη και δημιουργία ποιοτικής απασχόλησης: μια «Ελληνική Πράσινη Συμφωνία για Βιώσιμη Βιομηχανία και Ποιοτική Απασχόληση». Τα κύρια πλεονεκτήματα μιας εθνικής αποστολής είναι ότι θα μπορούσε να κινητοποιήσει όλους τους εμπλεκόμενους φορείς και να ευθυγραμμίσει τις προσπάθειες τους, καθορίζοντας μια σαφή κατεύθυνση, να συμβάλλει στη θέσπιση φιλόδοξων στόχων, να παρέχει μακροπρόθεσμη σταθερότητα, να ενοποιήσει συμπληρωματικές δράσεις σε όλα τα κυβερνητικά επίπεδα και χαρτοφυλάκια υπό την αιγίδα της, και να προωθήσει την άμεση λογοδοσία σχετικά με τα αποτελέσματα σε υψηλότατο πολιτικό επίπεδο (π.χ. το πρωθυπουργικό γραφείο).

Η σύνταξη ενός κειμένου διακήρυξης της αποστολής για βιώσιμη βιομηχανία και ποιοτική απασχόληση θα μπορούσε να αντλήσει έμπνευση από τους ήδη σαφείς, φιλόδοξους και χρονικά συσχετισμένους στόχους που περιέχονται στο Εθνικό Σχέδιο Ενέργειας και Κλίματος (NECP), καθώς και από τις προεκτάσεις και επιπτώσεις για την εγχώρια βιομηχανία και απασχόληση που προκύπτουν από την «Πράσινη Συμφωνία για την

προώθηση της ηλεκτροκίνησης[5]». Για να επιτευχθούν οι στόχοι μιας τέτοιας εθνικής αποστολής, θα χρειαστεί να αλλάξει ο τρόπος με τον οποίο διαμορφώνεται η βιομηχανική πολιτική, να επεκταθούν οι δράσεις της πέρα από την οριζόντια υποστήριξη για δραστηριότητες έρευνας και καινοτομίας (που πρέπει να ενισχυθούν ούτως ή άλλως) και να γίνει μετάβαση από δημόσιες επενδύσεις οι οποίες είναι τομεακά απομονωμένες και χωρίς σαφές αποτύπωμα σε βιομηχανική ανάπτυξη και απασχόληση προς μια πολύ πιο ολοκληρωμένη ατζέντα, η οποία θα γεφυρώνει τομείς πολιτικής που παραδοσιακά λειτουργούν σε μεγάλο βαθμό αυτόνομα. Η βιομηχανική πολιτική θα πρέπει να επεκταθεί πέρα από την πολιτική έρευνας και καινοτομίας ώστε να περιλάβει το σύνολο των εργαλείων πολιτικής που απαιτούνται για τη στήριξη των επιχειρηματικών επενδύσεων και τη μόχλευση όλων των σχετικών πόρων, συμπεριλαμβανομένων των δαπανών των νοικοκυριών, των επιχειρήσεων και της κυβέρνησης.

Ο υφέρπων ανταγωνισμός μεταξύ των πολιτικών στόχων της περιβαλλοντικής προστασίας, της κοινωνικής συνοχής και της οικονομικής ανάπτυξης, θα μπορούσε να υπερκεραστεί μέσα στο νέο αυτό πλαίσιο. Το νέο πλαίσιο, θα πρέπει να προωθεί συνέργειες μέσω της διερεύνησης, της ανακάλυψης και της προώθησης εκείνων των κατευθύνσεων που χρησιμοποιούν πόρους για την ταυτόχρονη επίτευξη των τριών στόχων: Την επιτακτική ανάγκη για *περιβαλλοντικά βιώσιμη εγχώρια βιομηχανική ανάπτυξη* που επίσης *δημιουργεί ευρεία απασχόληση υψηλής ποιότητας* και επιτρέπει στην Ελλάδα να *ευδοκιμήσει σε διεθνώς εμπορεύσιμους τομείς έντασης γνώσης*.

Εξετάστε το ενδεχόμενο να θεσπιστεί μια εθνική αποστολή για τη μετάβαση στην ενέργεια και την βιώσιμη κινητικότητα, της οποίας κεντρικοί στόχοι θα είναι η τοπική βιομηχανική ανάπτυξη και η δημιουργία απασχόλησης υψηλής ποιότητας. Η αποστολή θα μπορούσε να βασιστεί στην πρόσφατη ελληνική «Πράσινη Συμφωνία για την προώθηση της ηλεκτροκίνησης». Η θέσπιση της αποστολής θα πρέπει να συνοδευτεί από πρόσθετους μηχανισμούς που να επιτρέπουν τον συντονισμό εντός της κυβέρνησης και την ευρεία συνεργασία των εμπλεκόμενων φορέων.

Η θέσπιση μιας εθνικής αποστολή μπορεί να συμβάλει στην ανάδειξη της βιομηχανικής ανάπτυξης και απασχόλησης σε μείζον εθνικό στόχο, εφόσον επιτύχει την υποστήριξη όλων των κοινωνικών φορέων και δράσει ως πλαίσιο για κυβερνητική δράση μεταξύ υπουργείων, περιφερειών και δήμων. Για να μετατραπεί η αποστολή σε εθνικό σχέδιο που διαρκεί περισσότερο από οποιαδήποτε κυβερνητική θητεία, θα πρέπει να εξασφαλίσει πολιτική δέσμευση και υποστήριξη από όλες τις πλευρές του κοινοβουλίου.

Μια σαφής κατευθυντήρια γραμμή που θα εστιάζει τις προσπάθειες για *περιβαλλοντικά βιώσιμη* και *κοινωνικά δίκαιη* βιομηχανική ανάπτυξη *έντασης γνώσης* θα μπορούσε να μεταμορφώσει μεμονωμένα χαρτοφυλάκια πολιτικής που επί του παρόντος ανταγωνίζονται για πόρους (π.χ. περιβάλλον, απασχόληση και κοινωνική προστασία, επιχειρηματική στήριξη, έρευνα και καινοτομία, ενέργεια και υποδομές μεταφορών) σε μια ισχυρή συμμαχία για τον παραγωγικό μετασχηματισμό της οικονομίας. Εάν οι ενέργειες των κυβερνητικών φορέων που είναι υπεύθυνοι για αυτά τα χαρτοφυλάκια εξετάζονται και αξιολογούνται υπό το πρίσμα αυτής της κατευθυντήριας γραμμής, θα ήταν φυσικό να προκύψουν συμμαχίες ανάμεσα σε χαρτοφυλάκια πολιτικής, οι οποίες θα συνδυάζουν πόρους όπου είναι δυνατόν και θα επιδιώκουν συνειδητά συνέργειες ικανές να μεγεθύνουν τον αντίκτυπο των μεμονωμένων παρεμβάσεων, και να το επιτύχουν σε πολλούς τομείς.

Με απευθείας αναφορά στον Πρωθυπουργό, μια εθνική αποστολή θα ενίσχυε την λογοδοσία για το κυβερνητικό έργο, αλλά δεν θα αρκούσε από μόνη της για τον αρμονικό συντονισμό μεταξύ των υπουργείων και των διαφόρων επιπέδων διακυβέρνησης. Η προώθηση του ολιστικού σχεδιασμού και η διασφάλιση της αποτελεσματικής εφαρμογής του απαιτούν πρόσθετους μηχανισμούς συντονισμού. Τέτοιοι μηχανισμοί περιλαμβάνουν μεγαλύτερο ρόλο για «έξυπνες» ενδιάμεσες επιτροπές και ομάδες εργασίας, ικανές να μεγιστοποιήσουν τον συντονισμό και την επικοινωνία και να ελαχιστοποιήσουν τη γραφειοκρατική

[5] https://energypress.gr/news/20-foreis-ypegrapsan-tin-prasini-symfonia-gia-tin-proothisi-tis-ilektrokinisis-olokliro-keimeno

υπερφόρτωση· σημαντικό ρόλο εφαρμογής για τους δήμους (που συνδυάζουν πολλούς τομείς πολιτικής και είναι πιο κοντά στους πολίτες)· και την παράλληλη ανάπτυξη τοπικών «οδικών χαρτών» και «συλλογικών προγραμμάτων». Η ανάπτυξη συλλογικών προγραμμάτων θα μπορούσε να βασιστεί στην πρόσφατη εμπειρία συμμετοχικής διακυβέρνησης στο πλαίσιο της ανάπτυξης στρατηγικών έξυπνης εξειδίκευσης (π.χ. χρησιμοποιώντας εργαστήρια Επιχειρηματικής Ανακάλυψης) αλλά θα πρέπει να έχει ευρύτερη αρμοδιότητα που να συνάδει με τα πεδία δράσης που απαιτούνται για τη μετάβαση.

Η επίλυση ζητημάτων συντονισμού δεν αποτελεί αποκλειστική ευθύνη της κυβέρνησης. Εντύπωση προκαλεί το γεγονός ότι, σε σύγκριση με άλλες Ευρωπαϊκές χώρες, οι επιχειρήσεις του κλάδου δεν αναζητούν αμοιβαία επωφελή αποτελέσματα. Η απουσία πρωτοβουλιών για την αναζήτηση, τον εντοπισμό και την εκπροσώπηση των συλλογικών συμφερόντων ενός εξαιρετικά ποικιλόμορφου τομέα, ο οποίος περιέχει επιχειρήσεις όλων των μεγεθών και μια μεγάλη ποικιλία τεχνολογιών, είναι από μόνη της πηγή ανησυχίας. Αυτό το κενό θα πρέπει να καλυφθεί ως μέρος ευρύτερων προσπαθειών για την οικοδόμηση ενός αποτελεσματικού συστήματος εμπλοκής κύριων συμμέτοχών.

Χαράξτε πολιτικές με σκοπό τη δημιουργία *νέων αγορών* που να μπορούν να οδηγήσουν και να καλύψουν το κόστος της μετάβασης μακροπρόθεσμα. Η πιο επείγουσα παρέμβαση σε αυτόν τον τομέα είναι η θέσπιση συγκεκριμένων μέτρων για την εφαρμογή της περιβαλλοντικής νομοθεσίας, ένα βήμα που θα αποτρέψει τους «λάθρα επωφελουμένους» και θα ενισχύσει την περιβαλλοντική βιωσιμότητα ολόκληρης της βιομηχανίας.

Ορισμένες από τις αγορές που θα μπορούσαν να οδηγήσουν στη οραματιζόμενη μετάβαση δεν υπάρχουν ακόμη, και θα χρειαστεί δημιουργικότητα και μελλοντοστραφή κυβερνητική πολιτική προκειμένου να υποστηριχτεί η δημιουργία τους. Μέτρα δημιουργίας νέων αγορών περιλαμβάνουν τη θέσπιση νομοθεσίας για την ανάπτυξη και χρήση νέων τεχνολογιών, την καθιέρωση ρυθμίσεων για τη χρήση της γης (που καλύπτει, για παράδειγμα, την παραγωγή και συσσώρευσή ενέργειας σε μικρής κλίμακας υδροηλεκτρικά αντλιοστάσια, τη διαχείριση βιομηχανικών αποβλήτων και την ανακύκλωση), μέτρα που αποσκοπούν στην ενθάρρυνση των επενδύσεων και στην αύξηση των αποδόσεων τους, τη στρατηγική χρήση των δημοσίων συμβάσεων για την τόνωση νέων αγορών και υποστήριξη για την παροχή υποδομών δημόσιας χρήσης (π.χ. αναβαθμισμένο δίκτυο, εγκαταστάσεις φόρτισης ηλεκτρικών οχημάτων και ανεφοδιασμού υδρογόνου).

Πολλά θα μπορούσαν να επιτευχθούν με την ανάπτυξη δημόσιων υποδομών που ακολουθούν τη λογική της βιομηχανικής ανάπτυξης. Χρηματοδοτούμενες είτε απευθείας από δημόσιους πόρους, ή σε συνεργασία με τις επιχειρήσεις (π.χ. μέσω συμπράξεων δημόσιου και ιδιωτικού τομέα), ορισμένες ανάγκες υποδομής ξεχωρίζουν ως ιδιαίτερα σημαντικές. Σε αυτές περιλαμβάνονται αναβαθμισμένα και διευρυμένα δίκτυα μεταφοράς και διανομής ενέργειας, μέσα μαζικής μεταφοράς, υποδομές φόρτισης εξηλεκτρισμένων οχημάτων (συμπεριλαμβανομένων και των λιμένων για πλωτά μέσα), υποδομές ανακύκλωσης μπαταριών και έξυπνα δίκτυα.

Ένα πρόσθετο μέτρο δημιουργίας νέων αγορών, ιδιαίτερα επωφελές για τις καινοτόμες μικρομεσαίες επιχειρήσεις (ΜΜΕ), θα ήταν η δημιουργία «εργαστηρίων ρυθμιστικών δοκιμών» (regulatory sandboxes). Τα εργαστήρια ρυθμιστικών δοκιμών είναι προστατευόμενοι και επιβλεπόμενοι χώροι όπου οι υπό όρους εξαιρέσεις από το ισχύον ρυθμιστικό πλαίσιο επιτρέπουν τον γρήγορο πειραματισμό, τη μάθηση και τη καινοτομία. Ωστόσο, η θέσπιση εργαστηρίων ρυθμιστικών δοκιμών θα ήταν συνετή μόνο εάν η Ρυθμιστική Αρχή Ενέργειας, και ενδεχομένως άλλες ρυθμιστικές αρχές, όπως αυτές που ρυθμίζουν τη χρήση προσωπικών δεδομένων και τη λειτουργία του ανταγωνισμού και των τηλεπικοινωνιών, θα μπορούσαν να αναβαθμίσουν τις διαχειριστικές ικανότητες τους, διασφαλίζοντας παράλληλα την ανεξαρτησία τους.

Σχεδιάστε παρεμβάσεις έτσι ώστε η καταναλωτική ζήτηση να γίνει μοχλός βιομηχανικής ανάπτυξης και να διευκολυνθεί η συνεργασία που οδηγεί σε καινοτομία σε επίπεδο συστήματος.

Ως μέρος της εθνικής αποστολής, θα είναι σημαντικό να προετοιμαστεί και δημοσιευτεί εκ των προτέρων ένας μακροπρόθεσμος οδικός χάρτης των προβλεπόμενων δημόσιων παρεμβάσεων για τη μετάβαση που χαρακτηρίζεται από κατάλληλη και αποτελεσματική *αλληλουχία* παρεμβάσεων πολιτικής. Εξετάστε, για παράδειγμα, την παροχή υποστήριξης για την ενίσχυση της εγχώριας παραγωγικής ικανότητάς (συμπεριλαμβανομένης της υποστήριξης για κοινοπραξίες με κορυφαίους παγκοσμίως παραγωγούς και άλλα μέτρα που διευκολύνουν τις ξένες επενδύσεις) σε εκείνες τις κατηγορίες προϊόντων και εκείνες τις υπηρεσίες που θα χρειαστούν τα νοικοκυριά για τη μετάβαση, αλλά αυτό να γίνει *πριν* επιδοτηθούν οι επενδύσεις των νοικοκυριών σε ενεργειακή αποδοτικότητα, οικιακές λύσεις ΑΠΕ, αποθήκευσης ενέργεια και εξηλεκτρισμένης κινητικότητας.

Πολλές άλλες αλλαγές στο παραγωγικό σύστημα μπορούν να πραγματοποιηθούν από τις επιχειρήσεις και τους ίδιους τους συμμετέχοντες, ωστόσο η κυβέρνηση θα πρέπει να διαδραματίσει καθοριστικό ρόλο ως ενορχηστρωτής συνεργασιών. Μία από τις πιο ενδιαφέρουσες ιδέες που προέκυψαν από τις συζητήσεις με τους εμπλεκόμενους φορείς ήταν η πιθανή μετατροπή των ενεργειακών ισοζυγίων ΑΠΕ στα νησιά σε ισοζύγια υπηρεσιών κοινής ωφελείας, χρησιμοποιώντας σύγχρονες ψηφιακές τεχνολογίες διανεμημένων ισοζυγίων (distributed ledger technologies).

Στην πράξη, αυτό θα επέτρεπε στα νοικοκυριά και τις επιχειρήσεις στα νησιά που παράγουν τη δική τους ενέργεια να ανταλλάξουν πλεονάσματα που δεν χρησιμοποιούν με υπηρεσίες κοινής ωφέλειας που χρειάζονται, όπως νερό, συλλογή απορριμμάτων ή αποχέτευση (η επεξεργασία των οποίων είναι ενεργοβόρα). Η εισαγωγή μιας τέτοιας συστημικής καινοτομίας θα επιτύγχανε την ταυτόχρονη προώθηση των επενδύσεων των νοικοκυριών και των επιχειρήσεων σε ΑΠΕ και αυξημένη αποδοτικότητα επενδύσεων σε οικονομικές δραστηριότητες υψηλών ενεργειακών αναγκών στα νησιά, όπως οι υποδομές αφαλάτωσης και εγκαταστάσεις διαχείρισης οικιακών αποβλήτων.

Προσφέρετε πειστικές επιλογές εξέλιξης σε αυτές τις περιοχές (όπως η Δυτική Μακεδονία και η Μεγαλόπολη) και κοινωνικές ομάδες που απειλούνται από τη μετάβαση (όπως οι εργαζόμενοι στους κλάδους που εξαρτώνται από ορυκτά καύσιμα), εκτός εάν αναζητηθούν εφικτές εναλλακτικές λύσεις. Οι άνευ προηγουμένου πόροι της ΕΕ για την υποστήριξη της μετάβασής τους ανοίγουν νέες δυνατότητες οι οποίες, ωστόσο, πρέπει να συνοδευτούν από αυστηρές δικλείδες ασφαλείας σωστής διακυβέρνησης.

Για παράδειγμα, αξίζει να διερευνηθεί η πιθανότητα μελλοντικής εξέλιξης της Δυτικής Μακεδονίας σε διεθνούς φήμης περιφέρεια για την παραγωγή γνώσης και την επίδειξη νέων τεχνολογιών στον τομέα της *αποκατάστασης του περιβάλλοντος*. Η βαριά περιβαλλοντική κληρονομιά των σταδιακά μειούμενων δραστηριοτήτων εξόρυξης και καύσης άνθρακα αποτελεί ένα μείζον πρόβλημα. Είναι ακριβώς η ανάπτυξη λύσεων για ένα μείζον πρόβλημα, από τις οποίες μπορούν να προκύψουν μοναδικά οικονομικά πλεονεκτήματα. Η επίλυση των περιβαλλοντικών προβλημάτων της Δυτικής Μακεδονίας θα μπορούσε να αποτελέσει και τη λύση για τα εργασιακά και κοινωνικά της προβλήματα, εάν η άνευ προηγουμένου ευκαιρία χρηματοδοτικής στήριξης της ΕΕ – με τη μορφή του Ταμείου Δίκαιης Μετάβασης και των σχεδίων ανάκαμψης και ανθεκτικότητας - κατανοηθεί και εφαρμοστεί αποτελεσματικά. Η υπέρβαση των προκλήσεων που θέτει η αποκατάσταση των ορυχείων, των υδάτινων πόρων, και της γης θα μπορούσαν να οδηγήσουν σε μια σειρά από μοναδικές τεχνολογίες περιβαλλοντικής αποκατάστασης, η ζήτηση για τις οποίες αναμένεται να αυξηθεί καθώς η παγκόσμια κοινότητα επιδιώκει επειγόντως να αντιμετωπίσει την κλιματική αλλαγή.

Η μετάβαση παρέχει επίσης μια ευκαιρία για αναβάθμιση και διεύρυνση του εξαιρετικά ελλιπούς συστήματος επαγγελματικής εκπαίδευσης και κατάρτισης (ΕΕΚ) στην Ελλάδα. Πέρα από τη διευκόλυνση της βιομηχανικής ανάπτυξης, ένα αναβαθμισμένο και διευρυμένο σύστημα ΕΕΚ θα μπορούσε να προσφέρει ευκαιρίες ανέλιξης σε εργαζόμενους με χαμηλότερο εισόδημα, οι οποίοι επί του παρόντος έχουν πολύ λίγες επιλογές για να αναπτύξουν τις δεξιότητές τους. Από την άποψη αυτή, η Ελλάδα θα μπορούσε επωφεληθεί ιδιαίτερα από την πρόσφατη πρωτοβουλία της ΕΕ για τα Κέντρα Επαγγελματικής Αριστείας (Centres for Vocational Excellence - COVE). Η συμμετοχή στην πρωτοβουλία COVE θα παρέχει ακριβώς την απαραίτητη ώθηση και κατεύθυνση για την αναβάθμιση και τη σύνδεση του συστήματος ΕΕΚ τόσο με τις τρέχουσες όσο και τις μελλοντικές ανάγκες της αγοράς. Αρχικά, τα COVE θα μπορούσαν να βοηθήσουν στη δημιουργία ενός μικρού αριθμού πρωτοποριακών κέντρων επαγγελματικής εκπαίδευσης, με απώτερο σκοπό την κλιμάκωσή τους ώστε να καλύψουν όλη τη χώρα αργότερα.

Παρακολουθήστε στενά τις τιμές ενέργειας, καθώς και το κόστος της αποθήκευσης ενέργειας και της περιβαλλοντικά βιώσιμης (εξηλεκτρισμένης) αυτοκίνησης και εξετάστε πιθανές πολιτικές που αυξάνουν το ποσοστό απόδοσης για τους επενδυτές και τις κάνουν πιο προσιτές για τους καταναλωτές.

Ένα περιβάλλον το οποίο επιτρέπει στις τιμές να προκύπτουν ανταγωνιστικά θα είναι καίριας σημασίας για την επίτευξη μειώσεων τιμών σε σύνδεση με την ταχεία ανάπτυξη των ΑΠΕ στην Ελλάδα. Το μέλλον ενεργοβόρων βιομηχανιών στην Ελλάδα - που περιορίζονται επί του παρόντος στην παραγωγή τσιμέντου, βωξίτη και νικελίου – θα εξαρτηθεί αποφασιστικά από τη συμβολή των ΑΠΕ στις μειώσεις τιμών χονδρικής που σήμερα παραμένουν σε εξαιρετικά υψηλά επίπεδα. Προκειμένου οι ΑΠΕ να συμβάλλουν στη διαρκή μείωση των τιμών της ενέργειας, είναι απαραίτητη μια σαφής πορεία για επενδύσεις στην αποθήκευση ενέργειας. Οι υπεύθυνοι χάραξης πολιτικής πρέπει να επιταχύνουν τον σχεδιασμό τους για μια εθνική στρατηγική για την αποθήκευση ενέργειας, η οποία θα πρέπει επίσης να περιλαμβάνει μέτρα για τη βιομηχανική ανάπτυξη και τη δημιουργία ποιοτικής απασχόλησης.

Στο μέλλον, καθώς η βιομηχανική μετάβαση προχωράει και το ενεργειακό κόστος πέφτει, η Ελλάδα είναι πιθανό να γίνει σημαντικός παραγωγός ανανεώσιμων πηγών ενέργειας στη Νοτιοανατολική Ευρώπη. Θα είναι σημαντικό να χρησιμοποιηθούν ενεργειακά πλεονάσματα με τρόπους που συμβάλλουν στην περαιτέρω βιομηχανική ανάπτυξη. Για παράδειγμα, στην μελλοντική χρονική στιγμή στην οποία θα επέλθει καθοριστική μείωση του ενεργειακού κόστους, θα παρουσιαστεί μια εξαιρετική ευκαιρία για την εισαγωγή πολιτικών που, συνδυαστικά με το μειωμένο κόστος ενέργειας, ενθαρρύνουν επενδύσεις σε ενεργοβόρες βιομηχανίες. Αυτές μπορεί να έχουν διαφορετικές μορφές σε διαφορετικά πεδία εφαρμογής, π.χ. στη μεγάλης κλίμακας παραγωγή ενέργειας (π.χ. ηλεκτρόλυση υδρογόνου, ανακύκλωση), σε πόλεις και σε νοικοκυριά (π.χ. ενεργειακές κοινότητες, ηλεκτροκίνηση, μαζικές μεταφορές, διαχείριση αποβλήτων) και στα νησιά (π.χ. μονάδες αφαλάτωσης, εξηλεκτρισμένη ναυτιλία, περιλαμβανομένων λύσεων υδρογόνου).

Η παρούσα επισκόπηση αποτελεί μόνο το σημείο εκκίνησης. Θα πρέπει να εκληφθεί ως έκκληση για δράση και να γίνει καταλύτης της εντατικοποίησης των προσπαθειών για τον προγραμματισμό και την υλοποίηση ενός περιβαλλοντικά βιώσιμου μέλλοντος για την Ελλάδα που θα οδηγήσει σε αυξημένη ευημερία και μεγαλύτερη κοινωνική συνοχή.

Ο κατάλογος δράσεων που ακολουθεί περιλαμβάνει τα πρώτα βήματα προς την κατεύθυνση της υλοποίησης των συστάσεων που προηγήθηκαν:

Τί;	***Ποιος;***	***Πότε;***
Σχεδιασμός και υιοθέτηση μιας εθνικής αποστολής για τη βιώσιμη παραγωγική ανάπτυξη και την ποιοτική απασχόληση. Υιοθέτηση κατάλληλων δομών διακυβέρνησης και παρακολούθησης ώστε να είναι εφικτή η διασύνδεση των τεχνολογικών και των κοινωνικο-οικονομικών προκλήσεων του οδικού χάρτη της μετάβασης.	• **Γραφείο Πρωθυπουργού (ΓΓ Συντονισμού)** • Υπ. Ανάπτυξης και Επενδύσεων • Υπ. Ψηφιακής Διακυβέρνησης • Λοιπά Υπουργεία, όταν απαιτείται • Περιφέρειες • Δήμοι	2021
Σύνδεση υφιστάμενων και μελλοντικών μέτρων στήριξης της ενεργειακής αποδοτικότητας στα νοικοκυριά (π.χ., Εξοικονομώ-Αυτονομώ, κίνητρα για ηλεκτροκίνηση), με επενδυτικά μέτρα που υποστηρίζουν το εγχώριο παραγωγικό σύστημα ώστε να προσφέρει σημαντικό μερίδιο των λύσεων, με εστίαση στην καινοτομία των επιχειρήσεων.	• **Υπ. Ανάπτυξης και Επενδύσεων** • Υπ. Περιβάλλοντος και Ενέργειας	2021-2028
Ανάπτυξη Συλλογικών Προγραμμάτων (shared agendas) σε τοπική κλίμακα για θέματα κινητικότητας με τη συμμετοχή της κοινωνίας των πολιτών, της αυτοδιοίκησης, των επιχειρήσεων και των ερευνητών.	• **Υπ. Υποδομών και Μεταφορών** • Περιφέρειες • Δήμοι	2021-2024
Επέκταση του ρόλου των Κέντρων δια βίου Μάθησης σε περιφερειακά Εργαστήρια Πράξης (fieldlabs), συνδυάζοντας την επαγγελματική κατάρτιση με την καινοτομία και τις δράσεις επίδειξης. Ενθάρρυνση της ενεργού συμμετοχής φορέων από την Ελλάδα στα European Centres for Vocational Excellence (COVEs).	• **Υπ. Παιδείας και Θρησκευμάτων** • Υπ. Εργασίας και Κοινωνικών Υποθέσεων	2021
Βελτίωση της ικανότητας επιβολής της περιβαλλοντικής νομοθεσίας ώστε να εξισορροπηθεί το ανταγωνιστικό πεδίο όσον αφορά της αειφόρες επιχειρηματικές πρακτικές.	• Υπ. Περιβάλλοντος και Ενέργειας • Περιφέρειες	2021
Επιτάχυνση της υιοθέτησης ειδικών επενδυτικών κινήτρων για Δυτική Μακεδονία και Μεγαλόπολη και άμεση δρομολόγηση των απαραίτητων χωροταξικών αλλαγών. Εξέταση του ενδεχομένου για ένα εμβληματικό έργο αποκατάστασης του περιβάλλοντος στη Δυτική Μακεδονία μέσα απ' το οποίο θα αναπτυχθούν μοναδικές για την Ελλάδα παραγωγικές ικανότητες και δυναμικό καινοτομίας.	• **Υπ. Ανάπτυξης και Επενδύσεων** • **Υπ. Περιβάλλοντος και Ενέργειας** • Περιφέρεια Δυτικής Μακεδονίας	2021
Διευκόλυνση άμεσων ξένων επενδύσεων μέσω κοινοπρακτικών σχημάτων με παγκοσμίου	• **Υπ. Ανάπτυξης και Επενδύσεων**	2021-23

κλίμακας βιομηχανικούς οίκους που δραστηριοποιούνται σε τεχνολογίες σχετικές με τις ΑΠΕ ή/και την ηλεκτροκίνηση και κατά προτεραιότητα εγκατάστασή τους στις επηρεαζόμενες περιοχές.		
Υποστήριξη του μετασχηματισμού 10-20 μη διασυνδεδεμένων μικρών νησιών σε ενεργειακά αυτόνομα με χρήση ΑΠΕ και για θέματα αφαλάτωσης.	• **Υπ. Περιβάλλοντος και Ενέργειας** • Υπ. Ναυτιλίας και Νησιωτικής Πολιτικής	2022-26
Παροχή κινήτρων για τη βαθμιαία απόσυρση των ορυκτών καυσίμων στις παράκτιες θαλάσσιες μεταφορές και ανάπτυξη των απαραίτητων υποδομών σε λιμάνια.	• **Υπ. Ναυτιλίας και Νησιωτικής Πολιτικής** • Υπ. Ανάπτυξης και Επενδύσεων	2023-26
Παροχή ισχυρών κινήτρων για επενδύσεις σε ηλεκτροπαραγωγή μέσω ΑΠΕ και αποθήκευση ενέργειας, συμπληρώνοντας τα υφιστάμενα καθεστώτα ενίσχυσης για ενεργειακή αποδοτικότητα κτηρίων. Επιτάχυνση των ενεργειών για την ανάπτυξη της εθνικής στρατηγικής για αποθήκευση ενέργειας, η οποία θα πρέπει να περιέχει συνοδευτικά μέτρα για βιομηχανική ανάπτυξη και δημιουργία ποιοτικών θέσεων εργασίας.	• **Υπ. Ανάπτυξης και Επενδύσεων** • **Υπ. Περιβάλλοντος και Ενέργειας**	2022-2026
Αναβάθμιση του ρόλου των Δημοσίων Συμβάσεων Καινοτομίας θέτοντας ποσοτικούς στόχους (π.χ. 2,5% επί του ετήσιου προϋπολογισμού των δημοσίων συμβάσεων). Εξασφάλιση των απαραίτητων πόρων για το σκοπό αυτό και βελτίωση της διαχειριστικής ικανότητας της δημόσιας διοίκησης.	• **Υπ. Ανάπτυξης και Επενδύσεων** • Υπ. Οικονομίας και Οικονομικών	2022
Αναζήτηση ενεργητικής συμμετοχής της Ελλάδας σε πρωτοβουλίες της ΕΕ που ενισχύουν τις παραγωγικές ικανότητες στον τομέα των ΑΠΕ και της αποθήκευσης ενέργειας, όπως η Ευρωπαϊκή Συμμαχία για τις Μπαταρίες, η Συμμαχία για το Υδρογόνο, τα IPCEI (συμπεριλαμβανομένης της μικροηλεκτρονικής), και ανάπτυξη διασυνοριακών συνεργασιών σε τομείς κοινού ενδιαφέροντος (π.χ. με Βουλγαρία και Ιταλία).	• **Υπ. Ανάπτυξης και Επενδύσεων (ΓΓΕΤ, ΓΓ ΕΣΠΑ)** • Υπ. Περιβάλλοντος και Ενέργειας • Περιφέρειες	2021-22
Κινητοποίηση της ανάπτυξης παραγωγικών οικοσυστημάτων επενδύοντας σε μηχανισμούς μεταφοράς γνώσης, π.χ. μέσω γραφείων μεταφοράς τεχνολογίας και θερμοκοιτίδων.	• **Υπ. Ανάπτυξης και Επενδύσεων** • Υπ. Παιδείας και Θρησκευμάτων	2021-2028

1 Introduction

This review of industrial transition in Greece is one of the activities of the Working Group Understanding and Managing Industrial Transitions (UM IT), under the JRC Project "RIS3 Support to Lagging Regions". The reviews, conducted in Greece and several other territories, aim to build the evidence base for appropriate "Actions to Manage Industrial Transitions", as stipulated in fulfilment criterion No.6 of the enabling condition of good governance foreseen in the next multi-annual financing period of the EU Structural Funds (without prejudice to the final decision of the European Commission). A central objective of the reviews is to contribute to the development of a credible positive vision for the territory. A co-created positive vision can act as a focusing device for collective inspiration, reflection, discussion and action that could catalyse the transition. The reviews themselves are a part-intelligence gathering, part-analytical, part-creative exercise that aspires to draw from high quality knowledge and expertise. They are the beginning of, and an input to, a process of vision co-development and action that will have to mobilise a broad group of stakeholders.

The reviews each focus on an industrial theme of growing global importance suggested by the relevant territorial authorities (in the case of Greece, the national authorities) to collect evidence and examine the scope for developing adequate territorial responses that harness cross-portfolio complementarities (e.g. between ministries and between levels of governance) and cross-stakeholder coordination (e.g. between businesses and broad constituencies of consumers/users). The report follows the concepts and methodological guidelines outlined in the JRC Technical Report "Projecting Opportunities for INdustrial Transitions (POINT): Concepts, rationales and methodological guidelines for territorial reviews of industrial transition" (Pontikakis et al., 2020).

The review of industrial transition in Greece is focusing on the agreed theme of *renewables, batteries and their applications in mobility, agriculture, shipping and defence*. While the review has been conducted at the national scale, it has taken into account sub-national realities. This mainly concerns the Regions of Western Macedonia and Peloponnese, as they both face the challenge of replacing their significant mining sectors for more economically and environmentally sustainable activities.

1.1 Reasons for the transition

The political context and the innovation challenge

The 2015 Paris Agreement under the United Nations Framework Convention on Climate Change (UNFCCC) set the goal to contain the rise in average global temperatures to well below 2 °C above pre-industrial levels and to pursue efforts to limit it to 1.5 °C. All Parties to the Paris Agreement were invited to submit mid-century strategies by 2020.

The European Union, following the Paris Agreement, has committed to reducing annual greenhouse gas emissions by 40% comparing to 1990 levels by 2030, and at least 80% by 2050.

The first chapter in the final report of the High-Level Panel of the European Decarbonisation Pathways Initiative (European Commission, 2018) provides a thorough review of the framework conditions that are highly relevant by the theme of choice by the Greek national authorities. They can be summarised as follows:

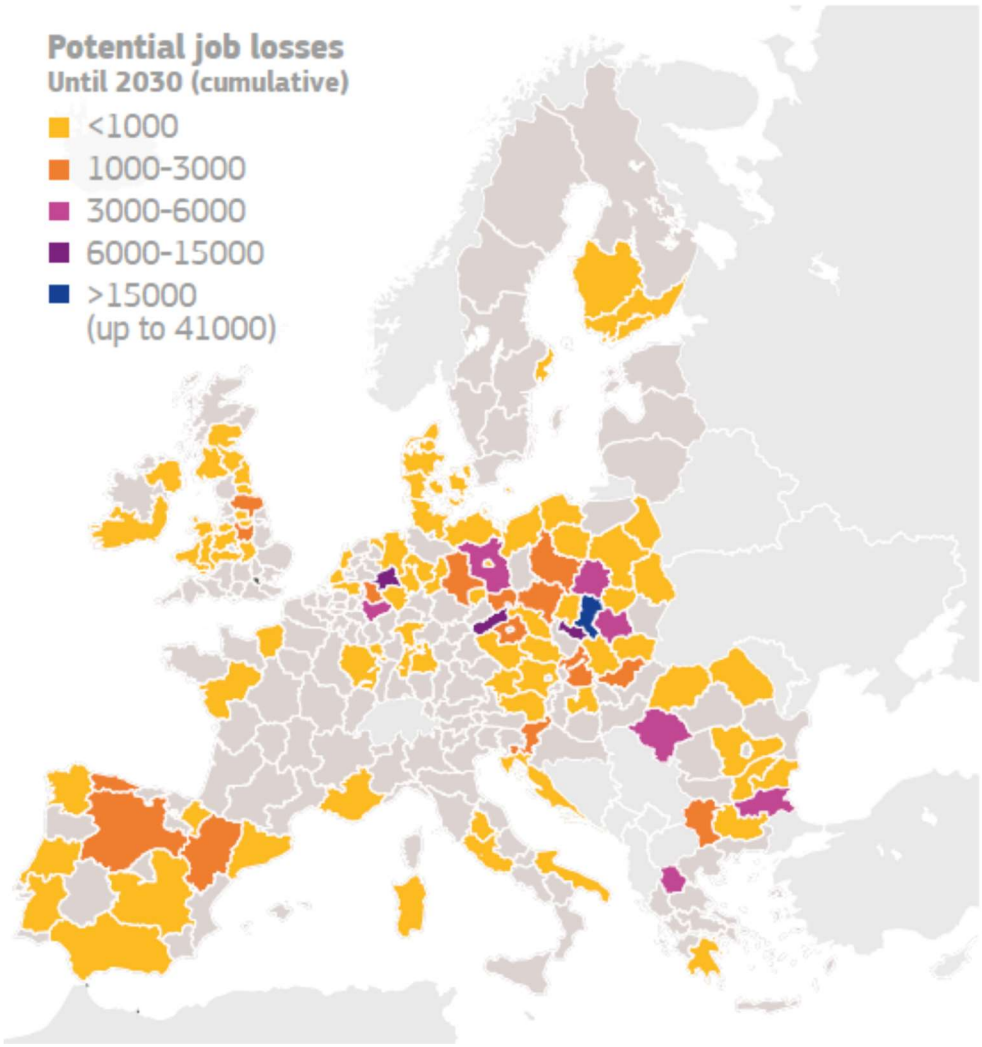
- The global economy, as we know it, operates in an unsustainable manner that is materially expansive, socially divisive and environmentally unfriendly;
- By stimulating the transition to the circular economy, by changing production processes and patterns of consumption, by recycling and drastically disposing biological resources, we could remove critical externalities, respect planetary boundaries, maximise inclusiveness, be financially and economically viable, and rely on intelligence, knowledge and information;
- The acceleration of decarbonisation, apart from contributing to climate stability and the quality of air, could also provide benefits for the EU in terms of much increased energy autonomy and savings on money spent on fossil-fuel imports. Moreover, from the perspective

of the economy and job creation, the EU could reap additional benefits by establishing its position as the frontrunner in the markets related to decarbonisation.

- Although the move to zero-carbon technologies creates tremendous new opportunities, the transition will be difficult and encounter many barriers since fossil fuels are currently interweaved in the fabric of our societies and economies.
- All transitions create winners and losers. Therefore, it is critical to ensure that no one is left behind.

Today, coal and lignite are mined in 41 NUTS2 regions in the EU (of which two, Western Macedonia and Peloponnese, are in Greece, see Figure 1) and there are coal-fired power stations in 103 NUTS2 regions. The structural change initiated by energy policy decisions poses enormous challenges for the regions affected and requires substantial resources that exceed the resources the regions dispose of.

Figure 1 Distribution of expected direct job losses in coal and lignite mining across EU. (Alves Dias, et al., 2018).



A climate-neutral Europe by 2050

In November 2018, the European Commission adopted a strategic long-term vision for a prosperous, modern, competitive and climate neutral economy by 2050 (European Commission, 2018). The strategy shows how Europe can lead the way to climate neutrality by investing into realistic

technological solutions, empowering citizens, and aligning action in key areas such as industrial policy, finance, or research – while ensuring social fairness for a just transition.

The EC's vision does not propose to change the 2030 climate and energy targets but will enable the EU to build on them and develop in due time policies towards 2050. It also clearly underlines that a transition towards climate neutrality cannot happen without the mobilisation of important growth-enhancing and supporting policies, such as competition, labour market, skills development, regional cohesion, taxation and other structural policies.

The road to a net-zero greenhouse gas economy could be based on joint action along a set of seven main strategic building blocks:

1. Maximise the benefits from Energy Efficiency including zero emission buildings. This is expected to reduce energy consumption by 50% between 2005 and 2050.
2. Maximise the deployment of renewables and the use of electricity to fully decarbonise Europe's energy supply. Large scale electrification of the energy system coupled with deployment of renewables will decarbonize EU energy supply and sufficiently reduce dependence on third-country suppliers. The cumulative savings from reduced imports is expected to amount to € 2-3 trillion over the period 2031-2050, thus freeing resources for further investments.
3. Embrace clean, safe and connected mobility. Decarbonising the transport sector by using alternative means of transport, connected and automated driving combined with the roll-out of electric vehicles and enhanced use of alternative fuels.
4. A competitive EU industry and the circular economy as a key enabler to reduce greenhouse gas emissions. Reaping first mover benefits by modernizing existing installations and investing in new carbon neutral and circular economy-compatible technologies and systems.
5. Develop an adequate smart network infrastructure and inter-connections. A modern and smart infrastructure, ensuring optimal sector coupling and enhancing regional cooperation is the cornerstone of the energy transmission and distribution landscape of tomorrow.
6. Reap the full benefits of bio-economy and create essential carbon sinks. Creating natural sinks by developing more sustainable land-use and agriculture.
7. Tackle remaining CO_2 emissions with carbon capture and storage. Compensating for remaining greenhouse gas emissions in the EU economy and creating negative emissions.

Member States would submit to the European Commission, by the end of 2018, their draft National Climate and Energy Plans, which are central for the achievement of the 2030 climate and energy targets and which should be forward-looking and consider the EU long term strategy. These plans would be revised to their final form after being reviewed by the EC services.

The European Green Deal

On 11 December 2019, Ursula von der Leyen, President of the European Commission, unveiled the European Green Deal (European Commission, 2019). It is a comprehensive set of environmental initiatives aimed at creating the world's first carbon-neutral continent by 2050, addressing a wide range of policy areas from state aid rules to a green industrial policy and a carbon border tax on imports to revamp rules and regulations so that ambitious climate goals are reached.

In terms of ambitions, the EU wants to become the first big economic bloc to reach zero carbon emissions by 2050, and it expects to propose a climate law in March 2020 to enshrine the target. The European Commission also wants to increase medium-term targets, cutting emissions by 50 to 55 percent in 2030, up from a current target of 40 percent.

It also plans to mobilize €100 billion of the EU budget and investment loans from the European Investment Bank to fund a "just transition" in regions whose economies currently rely on fossil fuels. Details of the Just Transition Mechanism were unveiled in January 2020.

Box 1: What is the European Green Deal?

Major global impulses, most notably climate change and pervasive digitalisation, call for radical transformation of production and consumption systems. The European Green Deal (EGD) is Europe's response, translating global impulses into opportunities and challenges for Europe, in line with its economic strengths and social values. The EGD is a sustainable growth strategy to achieve a climate-neutral Europe by 2050, i.e. no net emissions of greenhouse gases. It centres on policy measures for a green and inclusive transition, focusing on the energy sector, mobility, buildings, circular economy and natural resources in coordination with job creation.

The main policy areas and objectives of the 'European Green Deal'

Policy areas	Description	
ENERGY	► **Decarbonisation** (without fossil fuels i.e. coal, petroleum and natural gas) of the **energy sector** ► Cleaner sources energy (renewable energies)	Implementing measures to **reduce pollution** (air, water and soil) rapidly and efficiently
INDUSTRY	► Support industry to become leaders in the green economy with a greater focus on a clean and **circular economy** (more sustainable)	
MOBILITY	► Develop and invest in cleaner, cheaper and healthier forms of public and private **transport**	
BUILDINGS	► Buildings and renovating should be more **resource and energy-efficient**	
NATURAL RESOURCES	► Implementing measures to protect the fragile ecosystem (biodiversity) ► Ensuring more sustainable food systems (e.g. 'From Farm to Fork Strategy')	

For more details about the EGD see "Communication from the Commission to the European Parliament, The European Council, The Council, The European Economic and Social Committee and the Committee of the Regions – The European Green Deal", COM(2019), Brussels 11.12.2019.

The Greek National Energy and Climate Plan (NECP)

The draft Greek National Energy and Climate Plan (Greek Ministry of Environment and Energy, 2019) was prepared in January 2019 following the provisions of Regulation EU 2018/1999 and was finalized at the end of 2019 (Greek Ministry of Environment and Energy, 2019). Greek energy policy is based on two pillars. The need to ensure the development of the energy sector in its entirety (from production to end use) in a viable and sustainable manner. This should be conducted in a manner that protects the environment and contributes towards addressing climate change. Within the scope of the Plan, Greece intends to play an active part in the global effort made to reduce greenhouse gas emissions, most of which is generated by the energy sector. An additional key objective is to preserve and manage energy resources in a way that ensures the smooth, uninterrupted and reliable coverage of domestic energy needs, as well as access for all consumers (people, businesses and public sector bodies) to affordable and safe energy. The attainment of that objective relates to securing energy resources, by diversifying energy sources and flows, as well as by using domestic energy sources with a view to reduce the energy dependency of Greece, ensuring supply in the domestic market and protecting consumers in case of supply disruption and emergency.

The key policy priorities for the dimensions of decarbonisation envisioned within the Greek NECP are:

a) Reduction of emissions from conventional power plants and from the interconnection of autonomous island systems;

b) Encouraging the use of natural gas as an intermediate fuel for the decarbonisation of the energy sector;

c) Promotion of renewable energy sources (RES)

d) Encouraging improvement in energy efficiency of buildings, industry and infrastructure;

e) Reduction of emissions in transport;

f) Reduction of emissions in agriculture;

g) Reduction of emissions in tourism;

The quantitative targets set in the context of attaining the national energy and environmental objectives for 2030 in the framework of the NECP are as follows (Greek Ministry of Environment and Energy, 2019):

1. Reducing greenhouse gas emissions and environmental objectives: 40% decrease in greenhouse gas emissions versus 1990 and phase out of lignite-powered electrical plans by 2028.

2. Increasing the share of renewable energy sources in energy consumption:

    a. Share of RES in gross final energy consumption to reach at least 35% (without considering the contribution of RES in covering cooling needs);

    b. Share of RES in gross final electricity consumption to reach at least 60%;

    c. Share of RES in covering heating and cooling needs to exceed 40%;

    d. Share of RES in the transport sector to exceed 14 %, using the relevant EU calculation method.

3. Achieving energy savings in final consumption:

    a. Final energy consumption not to exceed 16.5 Mtoe in 2030;

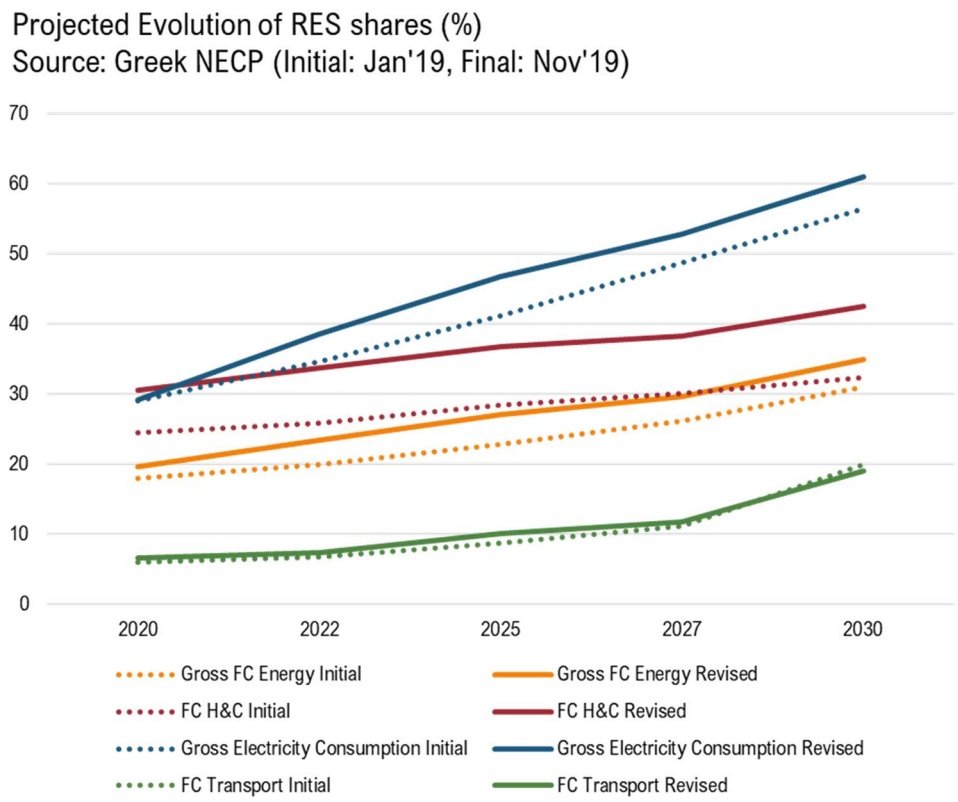
    b. Primary energy consumption not to exceed 22.5 Mtoe in 2030;

    c. Achieving cumulative energy savings of at least 7 Mtoe in the period from 2021 to 2030;

    d. Energy renovation to cover, on an annual basis, 3 % of the total surface area of the heated parts of central government buildings by 2030.

Figure 2 shows the projected evolution of RES shares by target and sector, as envisaged by the revised Greek NECP. The level of ambition in the revised version of the plan is considerably higher that of the draft eleven months earlier. The plan assumes that while the evolution of RES shares in electricity generation and heating will be relatively linear, the share of RES in transport will be more pronounced after 2027 when electric vehicles will reach considerable market penetration. At the end of the next decade, RES and advanced biofuels are expected to represent the dominant share of the electricity mix, as compared to all other fuels.

Figure 2 Projected evolution of RES shares in Greece (source: National Climate and Energy Plan: initial, Jan. 2019 and revised, Nov.2019)



In the field of RES electricity generation, according to the Greek NECP, the main modalities that are expected to contribute to the achievement of the targets are wind farms and photovoltaic parks, which are considered to be the most mature and competitive, and are subject to market and cost-effectiveness rules. Table 1 and Table 2 show the projected evolution of these figures for RES technologies in power generation and Table 3 shows the projected RES contribution in the transport sector.

Table 1 Projected evolution of installed capacity of RES units for power generation, in GW (source: NECP, Nov. 2019).

	2020	*2022*	*2025*	*2027*	*2030*
Biomass & Biogas	0.1	0.1	0.1	0.2	0.3
Hydro	3.4	3.7	3.7	3.7	3.7
Wind farms	3.6	4.2	5.2	6.0	7.0
PVs	3.0	3.9	5.3	6.3	7.7
Solar thermal plants	0.0	0.0	0.1	0.1	0.1
Geothermal	0.0	0.0	0.0	0.0	0.1
Total	10.1	11.9	14.5	16.3	18.9

Table 2 Projected evolution of electricity generation from RES units, in GWh. (Source: NECP, Nov. 2019).

	2020	*2022*	*2025*	*2027*	*2030*
Biomass & Biogas	0.4	0.5	0.8	1.0	1.6
Hydro	5.5	6.2	6.3	6.3	6.4
Wind farms	7.2	10.0	12.5	14.3	17.1
PVs	4.6	6.3	8.5	10.0	12.1
Solar Thermal plants	0.0	0.0	0.3	0.3	0.3
Geothermal	0.0	0.0	0.0	0.3	0.6
Total	17.7	23.0	28.4	32.2	38.1

Table 3 RES contribution in the transport sector, in ktoe. (Source: NECP, Nov. 2019).

	2020	*2022*	*2025*	*2027*	*2030*
Biofuels	228	238	283	287	371
Electricity	18	28	58	86	154
Total	246	266	341	374	525

The NECP and mobility

The NECP is a legal document of the highest legal order in Greece, that has placed the issue of decarbonisation high on the agenda. At this point it is unclear to what extent the revised version of the Greek NECP properly considers the parallel transition that is occurring in mobility, driven by improved battery technology, an increasing range of electric vehicles announced by manufacturers and consumer perceptions. There are several benefits from advancing on the transition towards the electrification of transport:

- It has strong complementarities with renewables (promoting electrification will favour renewable adoption and vice versa);
- Early adoption is worthwhile on its own right on account of efficiency gains and their effect on consumer welfare, and as an immediate response to long-standing air pollution in urban environments and its deleterious effects on human health;
- Early adoption may lead to the creation of so-called "lead markets"; technologically progressive consumers favour the development of business capabilities and associated goods and services, helping to secure a place in the newly emerging or rapidly transforming global value chains.

1.2 System definition and boundaries

The Review of Industrial Transition of Greece is focusing on renewables, batteries and their applications in mobility, agriculture, shipping, and defence. Given this mandate, the production and consumption system these topics are part of coincides with the territorial boundary of Greece. Within this geographic boundary, we identify the following analytical subsystems which are relevant to this Review:

1. *Supply side*. The main supply side actors from the perspective of this review include: producers of electricity, distributors of electricity (core), producers of biofuels (secondary), all other actors in the field of non-RES energy business aiming to diversify their activities (e.g., refineries, fuel distribution networks); manufacturers of batteries and accumulators, operators of hydroelectric facilities, recyclers of batteries and accumulators; manufacturers of components for photovoltaic panels, manufacturers of components for wind generators; distributors / retailers and repairers of motor vehicles; (Electric) Car manufacturers.
2. *Demand side*. The demand side covers final demand by individual consumers (electricity, electric cars) and households, as well as intermediate demands by enterprises (electricity in buildings and in industry, electric-powered logistics), public sector, public transport operators, and energy communities. There is also a category of actors that is positioned even more in between supply and demand, including system integrators and solution providers for RES infrastructures as well as system integrators and solution providers for applications of RES in transport, mobility, agriculture and defence.
3. *Government and Agencies*. At the national scale relevant actors include the Ministry of Environment and Energy, Ministry of Finance, Ministry of Infrastructure and Transport, Ministry of Economy and Development, Regulatory Authority for Energy (RAE), Centre for Renewable Energy Sources and Saving (CRES), Hellenic Energy Exchange S.A. (HEnEx SA), Renewable Energy Sources and Guarantees of Origin, Independent Power Transmission

Operator (ADMIE) S.A., Hellenic Electricity Distribution Network Operator (HEDNO). Additionally, also the sub-national authorities in regions like Western-Macedonia and Peloponnese are important stakeholders.

4. *Intermediaries*. Finance sector (banks, venture capital, business angels), technology transfer organisations, business support services (incubators, accelerators, consultancies).
5. *Civic Society*. NGOs in the field of the environment, business associations, trade unions.
6. *Research*. Higher Education Institutes and Public Research Organisations active in R&D in the fields of Materials Science, Electrochemistry, Surfaces Coatings and Films, Chemical Engineering, Electrical and Electronic Engineering, Energy Engineering and Power Technology, Energy and Fuels, Renewable Energy Sustainability and Environment, Control and Systems Engineering, Computer Science, Mechanical Engineering, Aerospace engineering, Mechanics, Materials and Composites, Civil and Structural Engineering, Transportation Systems.

The key research areas, patent classes, artefacts that constitute the system under review are presented in Table 8 in the Appendix. The last column also provides an overview of prominent actors relevant for each of the elements in the system. Taking a look at the major industries relevant for the system, Table 9 in the Appendix provides structural business statistics using the latest available data.

1.3 Headline targets and transition endpoints

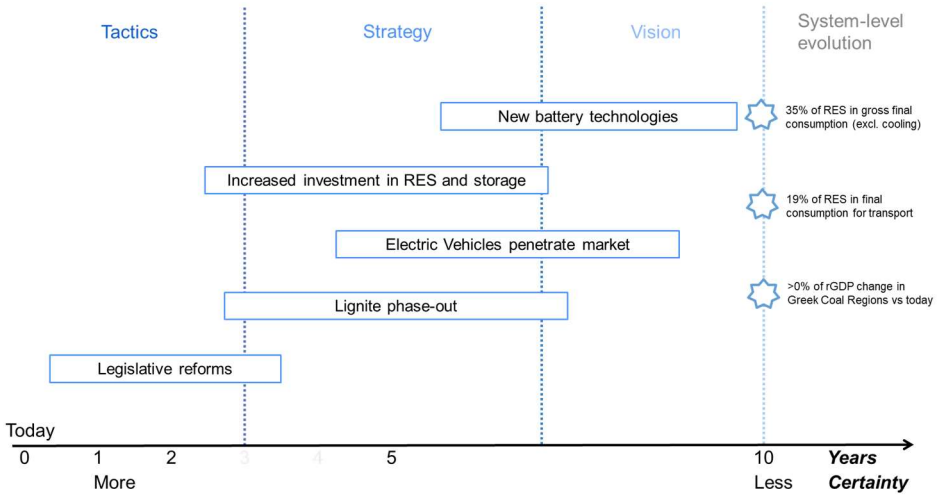
Headline targets

The focal industrial theme of batteries in conjunction with renewable energy sources and application areas like electric mobility was, as announced in the introduction, developed together with the Greek authorities involved in conducting this review. Directions for narrowing down the thematic scope are provided by the description of current policy objectives in Section 1.1 above, as well as an exploratory interview round with representatives of industry, policy, science and societal organisations.

Figure 3 provides the transition map of the system under review, based on policy documents and interviews used for refining the thematic scope. It was decided to focus on three long-term *headline targets*, of which two are explicitly mentioned in the current draft of the Greek NECP (share of RES in gross final consumption and share of RES in final consumption for transport) and one is implied: mitigation of the economic impact of the transition in the Greek coal regions[6]. The key factors that are expected to influence the trajectories for reaching these targets are also plotted as time windows in Figure 3. Their effects on the evolution of the key system variables is influenced by policy.

[6] The revised NECP explicitly refers to "…securing jobs and putting in good use the high-skilled human resources in these regions…" (p.5) and foresees a holistic and front-loaded Master Plan to support just transition that is expected to be ready by mid-2020. Therefore, this implied target might be revised in a future version.

Figure 3 The transition map of the system under review. Source: authors.



An important objective of this review is inspiring policy makers to reflect on the bold ambitious they can formulate in order to drive transformative changes the system normally would not achieve by itself. What is particularly promising in this respect are the fairly challenging policy goals regarding the share of renewables and the use of renewables in transport, seen in conjunction with the phase-out of lignite in electricity production. Precisely because it is so ambitious, the headline target of 20% RES use in final consumption for transport by 2030 might offer promising windows of opportunity. Perhaps even more than plain economic growth objectives, policy commitment to specific sustainability targets can spur demand for (and therefore the supply of) innovative solutions combining local industrial capabilities in the battery and renewable energy sectors. Linking these focal topics ideally yields synergies required for overcoming the inertia that holds back fruitful experimentation and economic diversification. Such an integrated transition direction has several advantages over considering all the components individually only:

- The industrial theme, composed of three core elements, is in keeping with the logic of smart specialisation in the sense that it focuses on applying a widely used (and demanded) technology in a locally strong sector. Tying battery development to modernizing logistic sectors may be regarded as a version of engaging in 'multiple value creation' by using the output of one system as an input for another system. Continuing the logic of building on regional strengths allows Greek policy makers to draw on their experiences with managing RIS3 strategies.
- The specific direction captured by the industrial theme is compared to regular S3, as it emphasises not just any general-purpose technology (or key enabling technology) but in particular the application of sustainability-enhancing technology. Here this concerns batteries in combination with renewable energy.
- The direction matches with current thinking[7] on achieving policy additionality by boosting development of activities which by themselves are unlikely to branch in many promising directions; see brief inspection of the Greek industry space[8] in Figure 4. Coloured nodes in this visualisation represent product categories in which Greece has relative comparative advantages, according to global export figures. The colour itself shows the industry these products belong to, while the distance between them reflects how related they are (on a global scale) in terms of capabilities, assets and/or institutions they draw on. Apparently,

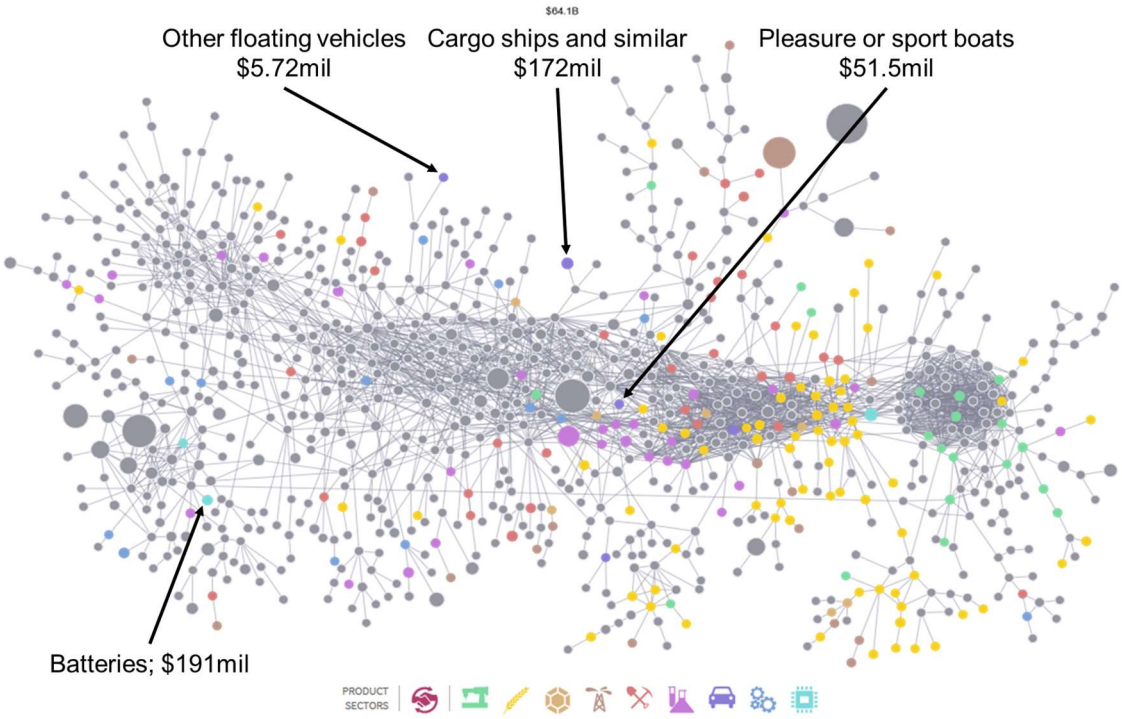
[7] See for example Hausmann and Chauvin, "Moving to the Adjacent Possible: Discovering Paths for Export Diversification in Rwanda", Centre for International Development at Harvard Working Paper 294, April 2015.

[8] See Atlas of Economic Complexity by the Growth Lab at Harvard University (http://atlas.cid.harvard.edu/)

battery development and vessel/ship building are rare strengths within the weak industries they belong to, and there are many advanced product categories in between them. Policy might help them to branch towards each other, thereby potentially also opening activity in products situated in between.

- The selected direction adheres to the notion of 'cross-specialisation' by using a societal theme (usage of renewable energy sources) as the interface for linking two unrelated local strengths.
- Finally, the strategy incorporates insights from 'modern industrial policy', 'transformative innovation policy' and transition thinking – and interest for adoption - by capturing also the socio-economic part of getting the theme implemented and diffused. Instead of targeting only R&D intensity or of devising a top-down economic planning program, the strategy invites for reflection on how development as well as adoption of innovative technologies, products and services can be tied to meeting societal objectives. A purely technologically or economically driven strategy would most likely be insufficient in this respect. While not explicitly stated in the industrial theme itself, its scope (covering both production and use of novelty) does allow for exploring how policy makers and representatives from science, industry and society can jointly explore viable transition routes - as well as the conditions needed for pursuing these routes.

Figure 4 Greek export product portfolio (2017) mapped on the global industry space.[8]



Transition endpoints

Starting from the industrial theme and its underlying components, a transition needs to be pursued that ultimately results in achieving the headline targets regarding RES use and economic performance. The success of such a battery-, RES- and transport-based transition depends on the ability to also respect other policy goals and widely shared public values. That is, the road towards achieving the goals should unfold within certain boundaries imposed by policy and society. Based on insights retrieved from the initial desk research and interviews, the *transition endpoint* (i.e. the resulting socio-economic system) should capture at least:

- The urge of upgrading public transport quality in the main cities, as the current service level is below standards due to poor maintenance and fleet shortages;

- The uptake of electric cars (incl. the deployment of distribution/charging infrastructure), as it is unclear how NECP targets on this account will be met;
- Economic diversification building on for instance battery technology capabilities (and ICT skills, especially in system integration), as these types of capabilities offer opportunities to develop economic activities that strengthen competitiveness (based on the 'complexity' of the products drawing upon such capabilities);
- The improvement of (renewable) energy supply for the islands, possibly based on local energy sources. Currently many of the islands still lack reliable energy provision.
- Although not strictly part of the aimed endpoints, a timely, knowledge-intensive and socially inclusive transition would have additional benefits such as improvements in the quality of public transport and improvements in air quality and thus public health.

Transition starting points

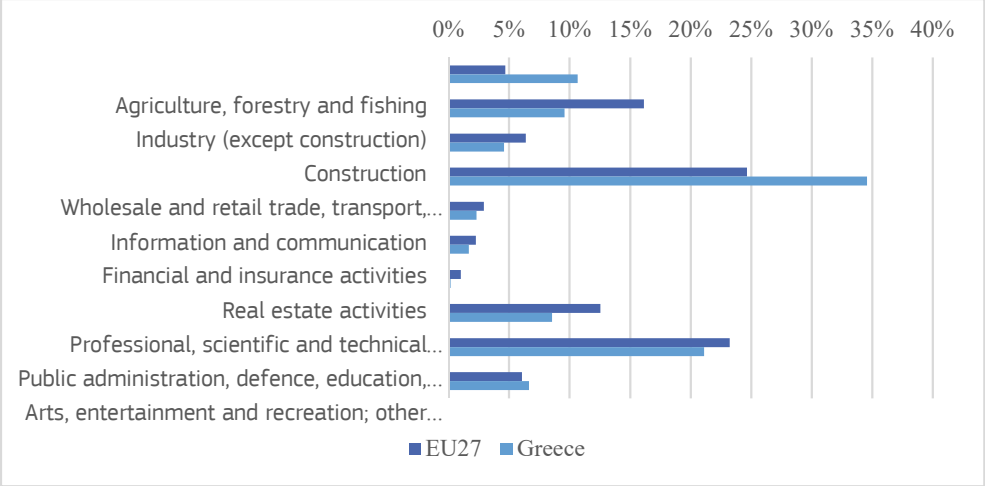
While it is hard to envisage in detail how the focal topics of batteries, RES and transport could be connected in one single policy strategy for achieving the headline targets, it is still possible to define the *starting points* for unleashing a comprehensive transition:

A unique window of opportunity, probably once-in-a-century moment, has emerged due to global technological and environmental impulses and growing attendant markets. The EU-wide focus on sustainability as a competitive advantage, the centrality of the Green Deal for Europe in the agenda of the new European Commission, the non-negotiable deadlines to achieve climate targets and a strongly articulated EU industrial policy in the fields of energy, mobility and digitalisation set the political scene for exploiting this opportunity.

The need to diversify the Greek economy is still very relevant. The 10-year crisis has exposed that the productive capabilities in tradables have been modest in an economy characterised by its excessive reliance on volatile tourism and non-internationally tradable services. This particular economic profile is demonstrated in the figure below, showing Greece's composition of employment (Q3 2019) in comparison to EU27 averages. 'Wholesale and retail trade, transport, accommodation and food service activities' (also including tourism) and 'Agriculture, forestry and fishing' make up for a disproportionate part of Greek employment, in contrast to employment in Industry. Table 6 in the appendix reveals that there are many manufacturing activities in the top 10 of sectors with high rates of job losses in the period 2008-2017, while tourism activities are in the top 5 of sectors with the highest rate of job growth.[9]

[9] The four positions higher in the top 5 of sectors with highest job growth figures are occupied by 'Waste collection, treatment and disposal activities; materials recovery', 'Employment activities', 'Information service activities', and 'Manufacture of basic pharmaceutical products and pharmaceutical preparations'.

Figure 5: Industry breakdown of employment figures (Q3 2019). Source: Eurostat.

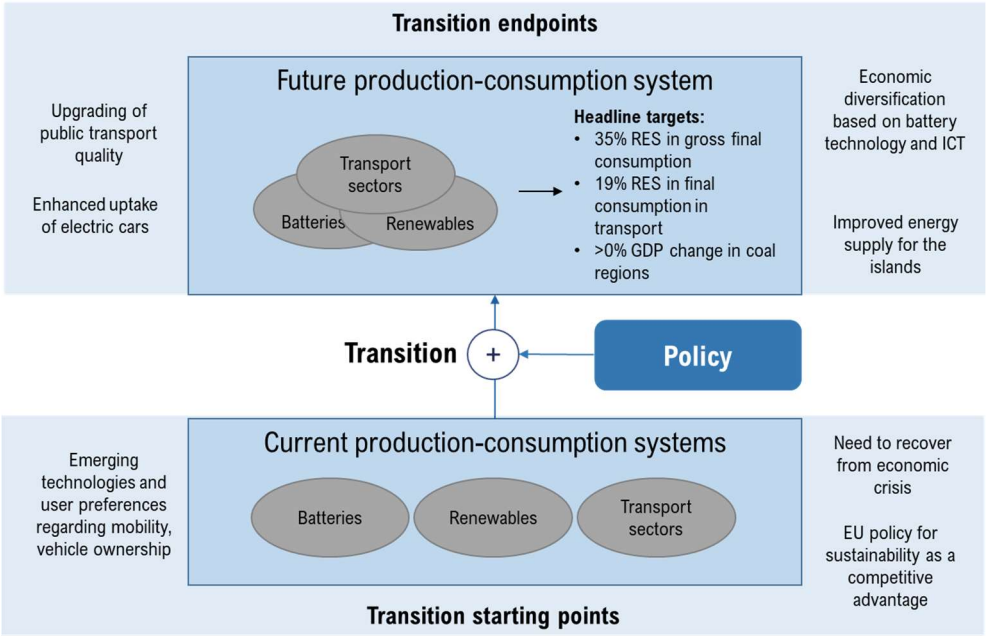


Overview

The national deadlines for phasing out lignite pose major challenges as indicated in NECP (Greek Ministry of Environment and Energy, 2019): especially the region of Western Macedonia, currently the centre of the Greek energy production, is threatened with an employment crisis and faces an economic restructuring challenge. Given the above (national social and political consensus, political and industrial visions aligned in Greece and EU, availability of infrastructures and relevant funds, arising global technological paradigms from which to tap from) this potentiality presents a window of opportunity, that can help to steer the Greek economy towards a more sustainable future. Particularly relevant in this respect are also the new paradigms emerging in the fields of mobility, vehicle ownership, vehicle powertrain technology. They will inevitably need new investments, both by government and businesses to drive consumer or household expenditures in new forms of energy, energy savings and transport. The benefits of preparing in advance are obvious.

The figure below highlights the relation between the industrial theme, the transition starting and endpoints, the transition process, and the ultimate headline target. The next three chapters address, subsequently, the current production-consumption system around the industrial theme's component, the envisaged production-consumption system, and the policies suitable for a successful transition from one system to the other.

Figure 6 Relation between the industrial theme, the transition process, the transition endpoints and the ultimate headline target.



2 The current state of the system

Actors, mechanisms, relations and framework conditions in the current state of the system

2.1 Orientation and Planning

Orientation and planning happen chiefly within government and businesses. Visionary entrepreneurs can play a key role as can public authorities. However, consumer trends do provide orientation since they are driven in part by shifting needs and tastes, changing social attitudes, pervasive social concerns and individual practices. As such, the latter, can be considered to be additional orientation and planning 'beacons'. Planning of relevance to the transition may take place across a wide range of policy portfolios, spread over several ministries and levels of government. Science, technology and innovation actors can play a key role in view of their position in spearheading knowledge development and in steering the system towards developing regionally- and potentially-globally relevant applications.

2.1.1 Public Policy

Government agencies and policies

The key actors in the Greek administration that are relevant to this review are line Ministries and other government agencies. Specifically:

The Council of Ministers (Cabinet) consists of the Prime Minister, the Deputy Prime Minister, the Ministers and the Deputy Ministers. It defines and directs the general policy of Greece in accordance with the definitions of the Constitution and the law, decides on political issues and on any matter of competence of collective governmental bodies or on any matter of competence of one or more Ministers referred to by the Prime Minister. The relevant decisions of the Council of Ministers replace the decisions of the competent bodies and finally exercises all other powers provided for by the Constitution and the Law. According to Law 4622/2019, the coordination and the evaluation of the government's work is delegated to the newly established government heaquarters (Προεδρία της Κυβέρνησης) chaired by a deputy minister. Within this, the General Secretariat for the Coordination of Economic and Development Policies is responsible for the coordination of the Ministries of Finance, Development and Investments, Foreign Affairs, Environment and Energy, Culture and Sports, Infrastructure and Transport, Maritime and Island Affairs, Rural Development and Tourism.

The Ministry of Environment and Energy is responsible for environmental and energy policy. The ministry oversees a total of 48 institutions or organisations, including the (independent) Regulatory Authority for Energy (RAE), the Centre for Renewable Energy Sources and Energy Saving (CRES/ΚΑΠΕ), responsible to promote renewable energy sources, energy efficiency and energy saving applications at national and international level, as well as to support all activities (technological, research, advisory, investment) in the above fields; the Independent Power Transmission Operator (IPTO/ΑΔΜΗΕ), responsible for the control, maintenance and development of the Greek electricity transmission system and for the operation of the market electricity related to non-Day-Ahead Scheduling (DAS) transactions; the Hellenic Electricity Distribution Network Operator (HEDNO/ΔΕΔΔΗΕ), responsible for the operation, maintenance and development of the electricity distribution network in Greece and for ensuring transparent and non-discriminatory access for consumers; and the Hellenic Energy Exchange (HEnEx) that manages the Energy Markets of physical delivery and the Energy Financial Markets. It also supervises the state-owned enterprises in the field of energy, such as the Public Power Corporation (PPC/ΔΕΗ) and its subsidiaries and Hellenic Petroleum (HELPE/ΕΛΠΕ) and its subsidiaries.

The Ministry of Development and Investments is responsible for the elaboration of the country's development strategy, public and private investments, industry and trade, public procurement and research & technology. It is also responsible for planning and implementation of ESIF programmes.

The Ministry of Finance is responsible for the budget, taxation, including energy taxation and other tax-related matters, and oversees the Hellenic Competition Commission (HCC) and other agencies.

The Ministry of Infrastructure and Transport is responsible for the strategic planning and implementation of the country's infrastructure projects, the planning and implementation of national policy on transport. It supervises among others, all public transport organisations.

The Ministry of Education is responsible for primary, secondary and tertiary education, vocational education and training and life-long learning. It supervises all Higher Education Institutions in Greece and the National Organisation for the Certification of Qualifications and Vocational Guidance that is responsible for the accreditation of qualifications.

The Ministry of Employment and Social Affairs is responsible for labour legislation, social security and solidarity. Among others, it oversees the National Employment Organisation (OAED), the National Institute for Labour and Human Resources (EIEAD) and is responsible for skills forecasting in Greece.

The Ministry of Rural Development and Food is responsible for agricultural policy, interventions in rural development and the rural economy of Greece, including, among many others, energy efficiency in agricultural holdings.

The Ministry of Maritime Affairs and Island Policy is responsible for shipping, port policy and maritime investment, fisheries and island policy, mainly focusing on the coordination and mobilisation of public and private players in the development of the islands.

With a view to attaining Greece's objectives for 2020, several measures and policies have been adopted. They are listed in the draft version of the NECP (Greek Ministry of Environment and Energy, 2019) mentioned in section 1.1, and can be summarized as follows:

- A total of 21 policy measures have been implemented to date, with a view to reducing greenhouse gas emissions. These policy measures consist of a mix of policy measures from different categories (technical, regulatory and financial);
- A total of 45 policy measures have been implemented to attain the three sub-targets for ensuring the highest possible penetration of RES;
- A total of 40 policy measures have been implemented to attain the four different energy efficiency targets, as developed in accordance with Articles 3, 4, 5 and 7 of Directive 2012/27/EU;
- A total of 42 policy measures have been implemented, aiming to attain the individual sub-targets regarding the security of supply;
- A total of 49 policy measures have contributed towards the attainment of different sub-targets regarding the energy market operation/dimension, dealing with electricity market interconnectivity and energy transmission infrastructure, regional cooperation, financing the consolidation of the energy market and addressing energy poverty.

One of the measures mentioned above has to do with the 10-yr (2018-2027) plan to improve the national electricity transmission system, which was proposed by the Independent Power Transmission Operator (ΑΔΜΗΕ), approved by the Regulatory Agency for Energy (RAE) and published in the Official Government Gazette in May 2018[10]. This replaces another 10-yr plan (2017-2026), also approved by RAE one year earlier, and is budgeted at €1.89bil of which approximately €1bil are to be committed in the period from 2018 to 2021 mainly for urgent improvements in the transmission network.

Another relevant policy development is the concept of Energy Communities, as defined by Law 4513/2018[11]. An Energy Community is an initiative for citizens, social organisations, local or city authorities, small and medium-sized local businesses to take part in energy projects as producers and consumers at the same time (Net Prosumers). The main goal of the energy communities is to promote social economy values and innovative energy solutions, as well as produce, distribute and exchange energy from renewable energy sources, in local or regional scale.

10 OGJ, vol. 2, issue 1750, 8 May 2019.

11 OGJ, vol. 1, issue 9, 23 January 2018.

Policy evaluation

The review team is not aware of any formal evaluation of the policies listed above. However, the latest NECP provides a (self-) assessment of the status and what needs to improve (Greek Ministry of Environment and Energy, 2019, pp. 83-93). The main policy or regulatory issues that were raised by the business sector during our fact-finding mission in Athens on 10 October 2019 are summarised as follows:

- Unacceptable bureaucratic delays in connecting prosumers (e.g. ~6 months for net metering stations with a nominal power less than 10 KWp, and 1-2 years for 500 KWp stations);
- Undefined regulatory-legislative framework regarding Storage. The only storage application that is currently permitted by law is the one for net metering (rooftop prosumers mostly) but only for self-consumption needs. Stored energy is still excluded from any kind of energy market;
- Behind the meter applications (e.g. storage, demand side response) are not allowed and in Medium Voltage connections even discouraged;
- Absence of innovation in networks due to lack of regulatory incentives or penalties;

And of course, since energy projects are usually big investment projects, any policy that supports rapid, red-tape-free implementation is more than welcome. The Greek Prime Minister inaugurated on 15 October 2019 a 154 MW wind park in Euboia owned by Enel Green Power that took 10 years to complete; after its initial licensing by RAE in 2009, the actual installation started in June 2017 due to major bureaucratic barriers[12].

2.1.2 Ambitions in the National Energy and Climate Plan

The EU-wide 2030 energy and climate targets are very ambitious and require concrete efforts across the economy, both at the national and at the European level. The NECP also represents an unprecedented opportunity for the Greek Government to explore better the synergies among policy portfolios and to adopt a holistic approach. The revised NECP delineates (Greek Ministry of Environment and Energy, 2019, pp. 75-80) an integrated governance structure that will be managed by the Government Committee on Energy and Climate that was established by Cabinet Act nr 31 of 30.9.2019[13].

Attract investment and identify financing opportunities

Mobilising new related investments and private finance will be a key part of implementing the NECP over the coming years. Clarity on policy objectives and instruments will be essential for identifying both the scope and scale of additional investment needs, thus making it easier to plan and mobilise different sources of funding. In the coming months Greece should clarify the instruments and reinforce the analysis of projected investment needs, existing barriers and possible sources of financing.

This detailed assessment is essential to ensure efficient and more targeted spending of State resources, to better inform industry on the direction of policies, and to attract new investments, with positive repercussions in terms of jobs and growth. The European Commission's current work on sustainable finance, aiming to reorient capital flows from private investors to environmentally sustainable investments, could help identify investment opportunities and mobilise private finance[14].

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12 See https://www.kathimerini.gr/1047179/gallery/epikairothta/politikh/kyr-mhtsotakhs-stoxos-na-ginei-h-ellada-prwtopora-stis-ananewsimes-phges-energeias

13 See https://lawnet.gr/law-news/%CE%B5%CE%BB%CE%BB%CE%AC%CE%B4%CE%B1/%CF%80%CF%85%CF%83-%CF%83%CF%8D%CF%83%CF%84%CE%B1%CF%83%CE%B7-%CF%83%CF%85%CE%B3%CE%BA%CF%81%CF%8C%CF%84%CE%B7%CF%83%CE%B7-%CE%BA%CE%B1%CE%B9-%CE%BB%CE%B5%CE%B9%CF%84%CE%BF%CF%85%CF%81%CE%B3%CE%AF/

14 See COM(2019) 285 final of 18.6.2019. The European Commission's proposals for the next multi-annual financial private capital in sustainable investments, 30% of the overall financial envelope of the InvestEU programme is expected to support the climate

Financing synergies will have to be exploited with future Union policies and Union financial instruments such as the European Structural and Investment Funds (ESIF) and the Connecting Europe Facility (CEF). The expected contribution of the ESIF in the programming period 2021-2027 is expected to be €19.2bil in 2018 prices, of which approximately 30% will be used to address the second policy objective, i.e. a Greener Europe. The challenge for the Greek authorities is to maximise private co-financing of projects related to energy efficiency, to the promotion of RES and to the development of smart energy systems, grids and storage systems.

According to the 2018 annual reports of the key business actors, Mytilineos Group, Terna Energy and Elpedison, new capacity (both in terms of RES and gas-powered units) is in their short-term planning. And as mentioned in Section 2.2, their first moves to secure financing have already been made. However, stakeholders in the market are mostly concerned with the removal of the lignite-powered plants in the system while the additional demand for electricity due to the inevitable electrification of transport is still not receiving the attention it is due. The same is true for storage capacity for the purpose of enhancing the grid stability in the scenario of considerable RES contribution in electricity production. There is less clarity in the government's planning for electrification. A joint ministerial committee (Ministry of Environment and Energy Ministry of Finances) was created in October 2019, with a mandate to propose policy measures for the electrification of transport. The output is due no earlier than June 2020[15].

Support industry, competitiveness, and innovation

The revised NECP is still rather unclear on how to support an integrated industrial strategy that prioritises competitiveness, sustainability, investments, trade infrastructure and innovation in a manner that would enable Greece to capture a share of the innovation dividend from green and ancillary technologies. Although six research priorities are articulated (see Table 22 in the revised NECP), their relevance to the existing industrial fabric and possible pathways for commercialisation are not addressed yet. Clearer, more focused strategies and properly budgeted innovation priorities could help Greece in this direction, especially if supported by targeted interventions across the entire value chain and well-designed public procurement of innovation schemes (e.g., in the fields of the two major public transport organisations of Athens and Thessaloniki and the non-interconnected Aegean islands).

2.1.3 Wider planning exercises

Fully integrate the social dimension

Addressing social aspects is essential in securing a successful clean energy transition. This encompasses notably employment aspects, including training, upskilling and reskilling, as well as adequate social protection for people affected by the energy transition. The energy poverty dimension also needs consideration, by assessing the number of households in energy poverty and where necessary defining an indicative objective to reduce energy poverty.

So far, the transition of Western Macedonia to a post-lignite era was first discussed in a WWF Greece Economic and Technical Assessment[16] in 2016. More recently, the European Commission's Structural

objectives. Under its Sustainable Infrastructure Window, the contribution to Union objectives on climate and environment should be even higher (55%). As part of the Connecting Europe Facility, a dedicated proportion of funds has been allocated to support cross-border renewable energy projects. All Member States are also encouraged to use EU ETS auction revenues for funding investments in emission reductions and removals, renewable energy, energy efficiency, research and innovation for clean energy and industry technologies.

14 See https://www.kathimerini.gr/1048325/article/epikairothta/ellada/ekponhsh-e8nikoy-sxedioy-gia-thn-hlektrokinhsh

14 See https://www.wwf.gr/images/pdfs/Roadmap_PostLignite_EN.pdf framework running from 2021-2027 foresee that at least 25% of Union funds should contribute to support climate mitigation and adaptation. To mobilise private capital in sustainable investments, 30% of the overall financial envelope of the InvestEU programme is expected to support the climate objectives. Under its Sustainable Infrastructure Window, the contribution to Union objectives on climate and environment should be even higher (55%). As part of the Connecting Europe Facility, a dedicated proportion of funds has been allocated to support cross-border renewable energy projects. All Member States are also encouraged to use EU ETS auction revenues for funding investments in emission reductions and removals, renewable energy, energy efficiency, research and innovation for clean energy and industry technologies.

15 See https://www.kathimerini.gr/1048325/article/epikairothta/ellada/ekponhsh-e8nikoy-sxedioy-gia-thn-hlektrokinhsh

16 See https://www.wwf.gr/images/pdfs/Roadmap_PostLignite_EN.pdf

Reform Support Service funded a technical assistance project, implemented by the World Bank Group, to develop a long-term transition strategy. This project is expected to deliver by mid-2020 and inform, among others, planning for the national and regional budgeting of ESIF for the next programming period. Until now, no special organisational settings have been in place at the national level to co-ordinate the transition efforts of Western Macedonia.

The revised NECP foresees a national master plan for supporting a just transition, due in the first half of 2020, which would consider, among others, investment and tax incentives, new infrastructure, reskilling, support for rural development and the valorisation of local natural resources.

Regarding energy poverty, the revised NECP foresees improvements to existing social tariff measures and to the Universal Service regime so that they address households in energy poverty. Other policy measures under consideration include an "energy card" and targeted funding programs to improve the energy efficiency of such households.

2.2 Resource mobilisation

Resource mobilisation concerns actors who have a capacity to shift or mobilise human and financial resources, including financial organisations (or more broadly financial markets), public funders and ministries with large public procurement/investment budgets, businesses, and education and skill providers, among others.

Public Infrastructure

The Independent Power Transmission Operator's (ΑΔΜΗΕ) has already developed a €1bil front-loaded investment plan for providing urgent updates to the national transmission system by 2021 and thus provide for additional capacity for new RES electricity production. This has created considerable interest for new investment, especially in terms of wind power in the Greek Aegean Islands and especially Crete (see Figure 3 in the Annex). Crete is expected to be connected with the mainland transmission system in Attica via a 380 km underwater cable by the end of 2022, while a second, 180 km interconnection of Crete with Peloponnese is expected to become operational by the end of 2020.

HEDNO (ΔΕΔΔΗΕ), in agreement with the Ministry of the Environment and Energy and having the approval of RAE, declared their intention to install public electric vehicle charging systems following Eurelectric's Distribution Network Operator (DSO) model. According to their plan[17], HEDNO will first install approximately 150 charging stations in the Greek islands and then 1500 charging stations in mainland Greece (22kW, 3 phase, AC Mode 3 in urban areas and DC Mode 4 fast chargers in the national highway network). These, in addition to the Government's recently expressed commitment to push for higher RES penetration in the country's energy mix and shut down all lignite powered energy plans by 2028 seem to have sent the proper signals to investors.

Human resources and skills

The educational system in Greece is primarily focused on educational programmes that lead to tertiary education. Vocational education and training (VET) often represents a less appealing and relatively weak component. This has shown that, at least until recent and ongoing reforms, vocational learning mainly took place during the job and was achieved in non-formal and informal settings. At the same time, formal qualifications are highly valued (as in the case of academic credentials) and are often associated with improved social mobility prospects, in some cases even regardless of whether they lead to jobs. Recent VET reforms, aimed at addressing some of the education and training challenges such as improving VET's ability to smooth the transition from education to the labour market, modernizing VET, providing better practical skills to improve the relevance of VET and creating a positive culture for VET, take place at times of strict fiscal consolidation and steady effort for gradual, but consistent, recovery of the Greek economy (Mavris, 2018).

[17] See https://www.deddie.gr/el/stratigiki-eksugxronismos/kainotomia/ilektrokinisi/

The official data for the University entrance exams of 2019 indicate that the number of first-year students in the 40 HEI departments relevant to this survey[18] was 5671 while 2714 students were admitted to 17 ICT-related departments. This suggests that the supply of university graduates to the sectors related to this report is more than adequate and will probably remain so.

Cedefop[19] reports that there is 40.16% education mismatch by age group 25-34 for high-educational level compared to 26.20% on EU average; at the same time under-skilling when hiring is 20.36% compared to 5.91% at EU level, and skills under-utilisation is 47.26% compared to 40.47% on EU average. Cedefop also forecasts that the supply of high-qualified workers is expected to exceed the demand, while medium-qualified workers are expected to be in a shortage, a situation which could give rise to skills mismatch. The demand for low qualified workers is expected to fall below the supply[20]. The ranking of Greece in Cedefop's EU skills index[21] for 2018 is 27th among EU28 with a score of 22.89, slightly above Spain that is the worst performer.

Compared to other EU countries, participation of adults in lifelong learning in Greece remains low and has tended to stagnate over time: it stood at 4.5% in 2017, compared to an EU average of 10.9% and systematic and coherent policies have largely been lacking. The 2015 National reform programme recognised that Greece was still in need of a long-term strategic vision for improving access to lifelong learning. Strengthening the learning outcomes dimension in all parts of education and training is considered a precondition for moving towards lifelong learning. This will not only provide the basis for a more transparent and open qualification system; it will also allow individuals to have their learning validated and recognised throughout their lives[22].

Civil society

There are several entities of the civil society in Greece that are very active in the fields related to this transition such as WWF Greece, the Hellenic Association of Photovoltaic Companies (HELAPCO), the Association of Photovoltaic Energy Producers (SEF), the Hellenic Wind Energy Association (HWEA), the Hellenic Institute of Electric Vehicles (HELIEV), the Greek Association of Renewable Energy Sources Electricity Providers (HELLASRES), the Greek Federation of Micro-Hydropower Electricity Producers, the Hellenic Biomass Association, the Hellenic Association of Independent Power Producers (HAIPP) and the Electric Boat Association of Greece (EBA Greece). The Network of Sustainable Greek Islands DAFNI is coordinating a wide range of projects and support activities to help islands embark on a sustainable development paradigm including RES storage and electric mobility applications. Energypress is the main Greek news portal dedicated to energy.

Environmental NGOs support the transition away from coal. In 2016, WWF Greece together with the Panteion University in Athens developed a Roadmap for the Transition of the Western Macedonia to a post-lignite era. WWF Greece also takes part in a project on Just Transition in Eastern and Southern Europe, which is supported by the European Climate Initiative of the German Ministry of Environment. Its goal is to develop an economic transition strategy for Western Macedonia. Moreover, the Greek branches of WWF, Greenpeace and ClientEarth have submitted a legal challenge against the two Greek power plants, Meliti I and Meliti II, for failing to carry out the required Environmental Impact Assessment (EIA) before issuing an environmental permit for both plants.

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18 Electrical, Mechanical, Chemical, Materials, Marine, Mining and Environmental Engineering.

19 See https://skillspanorama.cedefop.europa.eu/en/countries/greece?field_countries_tid=15&field_sector_tid=

20 See https://www.cedefop.europa.eu/files/cedefop_skills_forecast_2018_-_greece.pdf

21 The European Skills Index (ESI) is Cedefop's composite indicator measuring the performance of EU skills systems. The ESI measures countries' "distance to the ideal" performance. This ideal performance is chosen as the highest achieved by any country over a period of 7 years. The ideal performance is scaled to be 100 and the scores of all countries are then computed and compared to that. The ESI consists of three pillars; skills development, activation and matching, each of which measures a different aspect of a skills system. Basis of the ESI are 15 individual indicators from various international datasets. The scores are calculated across countries at the indicators' level. The scores are then averaged at the various layers and finally the Index score is formed. To illustrate, an Index (or pillar, sub-pillar etc.) score of 65 suggests that the country has reached 65% of the ideal performance. Thus, there is still 35% (100-65) room for improvement. A score of 100 corresponds to achieving the 'frontier', that is an aspirational target performance for that indicator. A score of 0 corresponds to a lowest-case performance.

22 See https://www.cedefop.europa.eu/files/greece_-_european_inventory_on_nqf_2018.pdf

The General Federation of the Public Power Corporation Workers (GENOP-DEI), one of the most active and influential labour unions in the country, is against delignitisation since it will affect the majority of its members.

The municipal authorities where lignite mines and lignite-powered plants are located have formed a Network of Energy Municipalities, currently chaired by the Mayor of Florina. They are also against delignitisation citing a forthcoming "violent transition" and "Armageddon for their constituencies"[23].

Private-sector financing

Global financial assets, which more or less represent the supply of capital invested or available for investment in the real economy, grew at an increasingly rapid pace—from $600 trillion in 2010 (9.5 times global GDP) to about $900 trillion today. Moreover, as the supply of financial capital has increased, its price has fallen. In 2008 the cost of borrowing began to decline in response to central bank intervention. Today, in the absence of attractive investment opportunities, large banks have been forced to invest in riskier projects. The marginal cost of debt for many large companies is now as low as 3%. This means that the after-tax cost of borrowing is at (or below) the rate of inflation - implying that in real terms, debt is essentially free (Mankins, Harris, & Harding, 2017).

At the global level, 2018 was characterised by significantly more investment flow to renewable power technologies (excluding large hydropower) – an estimated $272.3bn, or 65% of the total of all new generating capacity – than to other technologies, including fossil fuel or nuclear power generating plants. If hydropower projects larger than 50 MW are included (an additional $16bn), investment in renewable power would reach $288.3bn, or 69% of the total for all generation technologies.

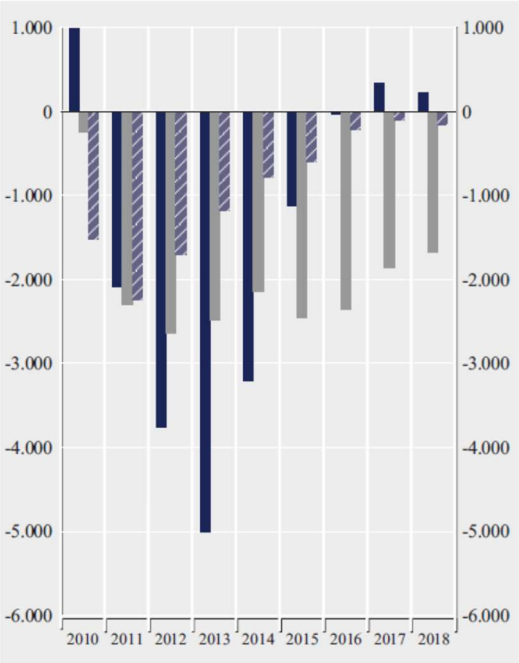
This compares to approximately $33bn committed to nuclear power capacity – largely new capacity in China and the Russian Federation – and $95bn committed to fossil fuel generating capacity (including $50bn for new coal-fired power stations and $45bn for gas-fired generators). The number of institutions divesting from fossil fuels has increased globally since 2011, although the funds are not necessarily reinvested in companies associated with renewable energy (REN21, 2019).

The Greek banking system is still plagued by the effects of the 12-year-old financial crisis, being marginally stable and unable to finance large investment. As shown in Figure 7, although there are signs of recovery in the net cash flows of bank loans for businesses for the second time since 2010, the net amount of €18m (vs €26m in 2017), is still very low compared to 2010.

The growth in economic activity in 2018 has had a strong impact on the demand for loans from non-financial enterprises, as the volume of production and sales indicators in several sectors have improved. Tourism, energy, shipping and agriculture recorded a positive net cumulative bank credit flow in 2018, while for other sectors whose performance indicators are improving, e.g. industry and commerce, banking finance figures have not yet seen a significant improvement. This discrepancy may be due in part to increased loan repayments in some sectors that may recover.

[23] See https://www.ethnos.gr/oikonomia/64042_sima-kindynoy-ekpempei-i-dytiki-makedonia-meta-tis-exaggelies-gia-ti-dei , https://xronos-kozanis.gr/ekklisi-gia-maziki-symmetochi-sto-syllalitirio-gia-ti-dei-ti-deytera-stis-5-m-m-stin-kentriki-plateia-tis-ptolemaidas/ and https://www.bloomberg.com/news/articles/2019-12-03/greece-s-ancient-power-is-in-crisis-on-climate-cost-collision

Figure 7 Cumulative net cash flows for loans, in million Euros, to enterprises (dark blue), and households (mortgages-dark grey and consumption loans-blue/grey) 2010-2018. Source: Bank of Greece, Governor's Annual Report 2018.



Given the limited availability of bank loans, most of the key actors in the energy market consider other financing options such as *joint ventures* and *corporate bonds*. In October 2019, Terna Energy SA issued a €150mil "green bond"[24] at 2.6% that was oversubscribed by 4.56 times. Two years earlier, the same company issued already a €60mil "green bond" at 3.85% that was oversubscribed by 1.5 times and was fully re-paid in June 2019. MYTILINEOS S.A. announced on 18 November 2019 that its direct Luxembourg subsidiary, Mytilineos Financial Partners S.A. intends to issue and offer €500mil aggregate principal amount of senior notes due in 2024. Given the low interest rates for Euro, similar options are available to most well-established players in the Greek market.

Joint ventures are also the norm. Terna Energy owns 50% of HERON I (50% owned by ENGIE group since 2007) and 25% of HERON II (50% owned by ENGIE and 25% by Quatar Petroleum since 2014). Elpedison is owned by Hellenic Petroleum (50%) and EDISON SpA (50%). Mytilineos Group founded ENDESA Hellas in 2007 as a joint venture with ENDESA and later repurchased their share.

Since 2005, the European Investment Bank has provided €4.45bil of loans to support investments in the Greek energy sector, including wind projects[25], power plants[26], improvements and extensions to both the transmission and distribution networks.

2.3 Production

Production concerns both actors active in manufacturing and services (including mining raw materials) as well as the generation and development of knowledge. This part of the system will chiefly involve businesses, but also universities, and vocational skills providers insofar as their activities are relevant to accumulating relevant knowledge and manufacturing/service provision capabilities.

[24] Green bonds, or climate bonds, are earmarked for financing sustainability-enhancing projects. The bonds might qualify for policy support in the form of e.g. tax incentives.

[25] E.g. www.eib.org/en/projects/pipelines/all/20170501 and www.eib.org/en/projects/pipelines/all/20160077.

[26] E.g., www.eib.org/en/projects/pipelines/all/20070202 and www.eib.org/en/projects/pipelines/all/20070191.

2.3.1 Raw Materials, Manufacturing and Services

Mining of other non-ferrous metal ores

Demand for rare earth metals is increasing as renewable energy becomes more important across the globe. Rare earths like neodymium and praseodymium, which are important in clean energy applications and high-tech industries, are in the spotlight, particularly as electric vehicles and hybrid cars gain popularity. Other factors, like the ongoing trade war between the US and China, are also putting the spotlight on rare earths. Since China is the world's largest producer of the materials by far, tensions between the countries are directing attention to rare earths supply chain issues.

Significant rare earth reserves are found in alluvial deposits in the coastal and underwater environment of the Strymonic Gulf between the homonymous river and Kavala. Specific field surveys carried out by the Greek Institute of Geological and Mineral Exploration (IGME) estimate stocks of 485 Mt with an average rare earth content of 1.17%. The bauxites and the bauxite laterites in Central Greece are also of interest for systematic field investigation with representative rare earth contents in the range of 3.28-6.4 Kg/t. The emerging exploration interest even includes red mud from aluminium metallurgy (see Figure 27 in the Annex).

LARCO, an ailing Greek state-owned mining company which is the largest ferronickel producer in Europe, is considering options for its restructuring. It has been recently proposed[27] to seek investors in deploying a hydrometallurgy process to extract cobalt from nickel ore and produce 2-3 Kt of cobalt per year. Cobalt needs across EU are estimated to be 53 Kt by 2025, but only 2.3 Kt are produced within the EU in Finland. The rest is imported, mainly from Russia and Congo.

Manufacture of batteries and accumulators

According to the official statistics (see Table 9 in the Annex), there were 13 manufacturers of batteries and accumulators in Greece in 2016, with an aggregate turnover of €177mil and 638 employees. Systems Sunlight S.A., with reported sales of €168mil in 2016[28], is the dominant actor, producing batteries for industrial (motive and reserve power), defence (submarines, torpedoes), consumer (power banks, batteries for household devices, chargers) and light industrial (UPS, alarm, lighting and signalling systems) applications. The rest of the sector, focusing mainly on the production or assembly of conventional vehicle (passenger cars, trucks and buses) batteries, has shrunk dramatically in recent years due to intense competition from imported products. As a result, most production plants that have operated in the past have stopped production, some of which have been idle while others remain in the industry now engaged in either battery imports or other activities such as battery recycling.

Collection, treatment and disposal of batteries, recovery of sorted materials

The Hellenic Recycling Agency (HRA, or EOAN in Greek) is the competent authority appointed by the Ministry of Environment & Energy for the design and implementation of recycling policy in Greece. It is responsible for approving national alternative management systems for each product and for controlling the progress of recycling within the Hellenic territory. The HRA has accredited four alternative management systems for waste batteries and accumulators, namely AFIS (primary focus on portable consumer batteries), SYDESYS, Re-Battery and COMBATT that focus on all other types of vehicle and industrial batteries. All these management systems of used batteries forward the batteries they collect to accredited recycling facilities such as AMEKON SA in Western Greece, METPLAST SA in Central Greece, SUNLIGHT RECYCLING SA, a subsidiary company of Systems Sunlight located in Eastern Macedonia-Thrace, IOANNIS KTISTAKIS in Central Macedonia, J HOUMAS SA in Attica and others. Most of the recyclers mentioned here focus on reusing or reselling lead (Pb). The entire system is well positioned in terms of collecting lithium-ion batteries, but there is no installed capacity to recycle lithium.

[27] See https://www.kathimerini.gr/1045887/article/oikonomia/epixeirhseis/larko-mporei-to-kovaltio-na-swsei-to-nikelio

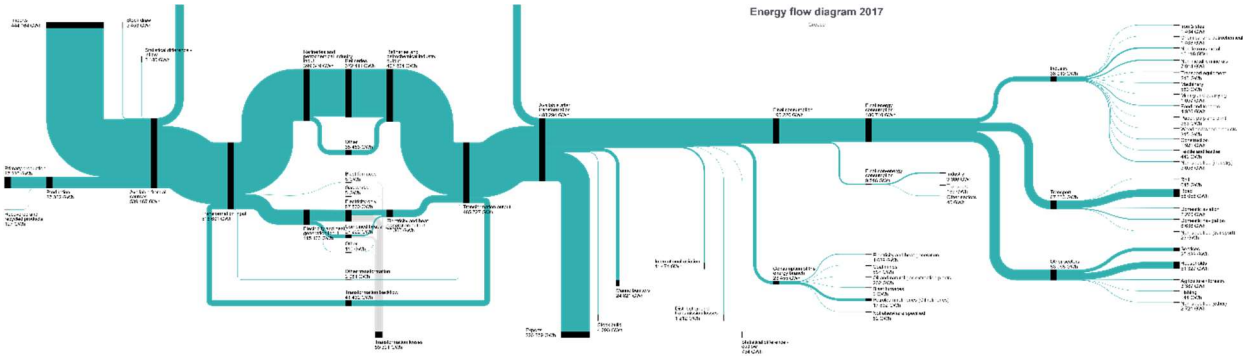
[28] See https://www.systems-sunlight.com/wp-content/uploads/2018/10/annual-report-for-the-financial-year-2016-final-restateden.pdf

Production and trade of electricity

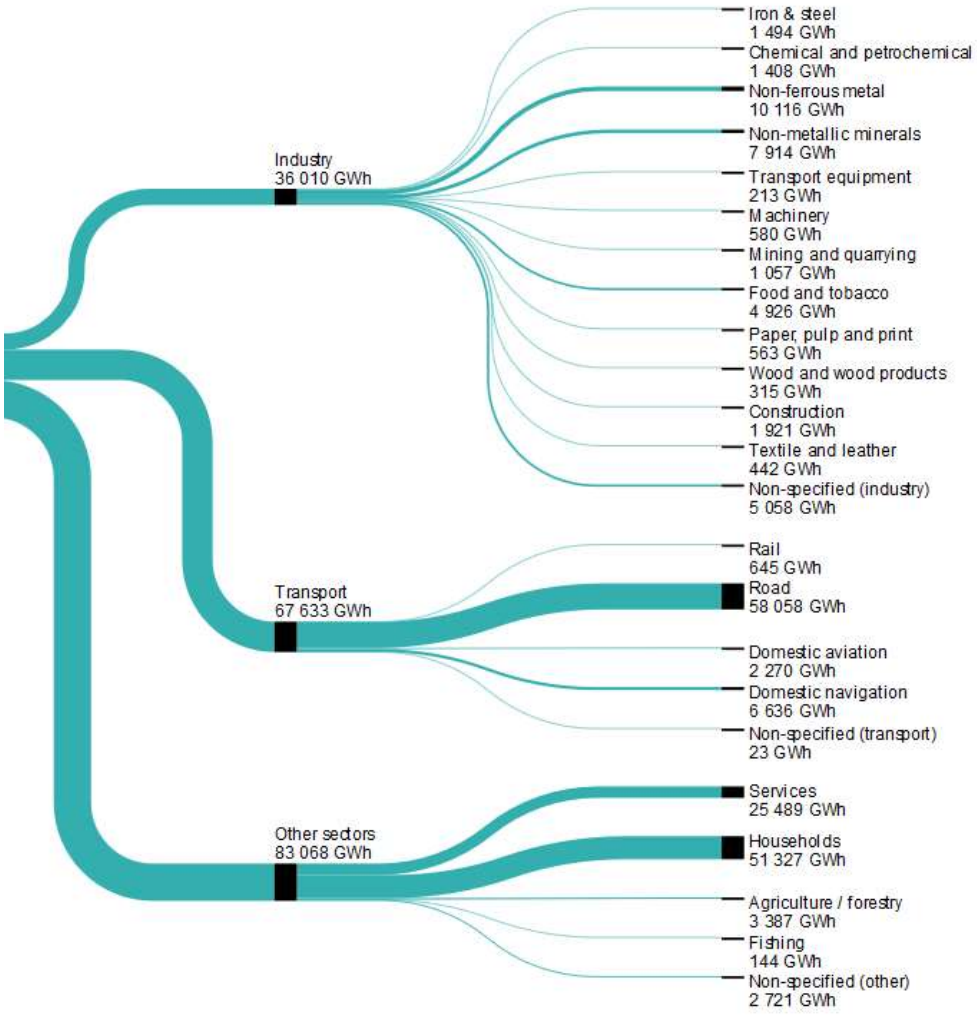
Figure 8 presents the energy flow in Greece in 2017 according to Eurostat data. The energy available from all sources was 539 TWh (46 360 ktoe), of which 444 TWh (38 191 ktoe) was imported. Electricity generation from all sources amounted to 61.5 TWh, of which 15.05 TWh were generated by renewable energy sources.

The backbone of the Hellenic Electricity Transmission System consists of three, double-circuit 400 kV lines, which transmit electricity mainly from Western Macedonia, where 70% of the country's generation capacity used to be located, to the major electricity demand centres of Central and Southern Greece where 65% of the country's electricity demand resides. The Hellenic Electricity Transmission System consists of additional 400 kV and 150 kV lines, as well as of 150 kV submarine cables, which interconnect Andros and the Ionian Islands (Corfu, Lefkada, Cephalonia and Zakynthos) and a 66kV submarine cable connecting Corfu to Igoumenitsa.

Figure 8 (a) Energy Flow Diagram for Greece in 2017. (b) Details on the final consumption, the right branch in (a). (Source: Eurostat).



(a)



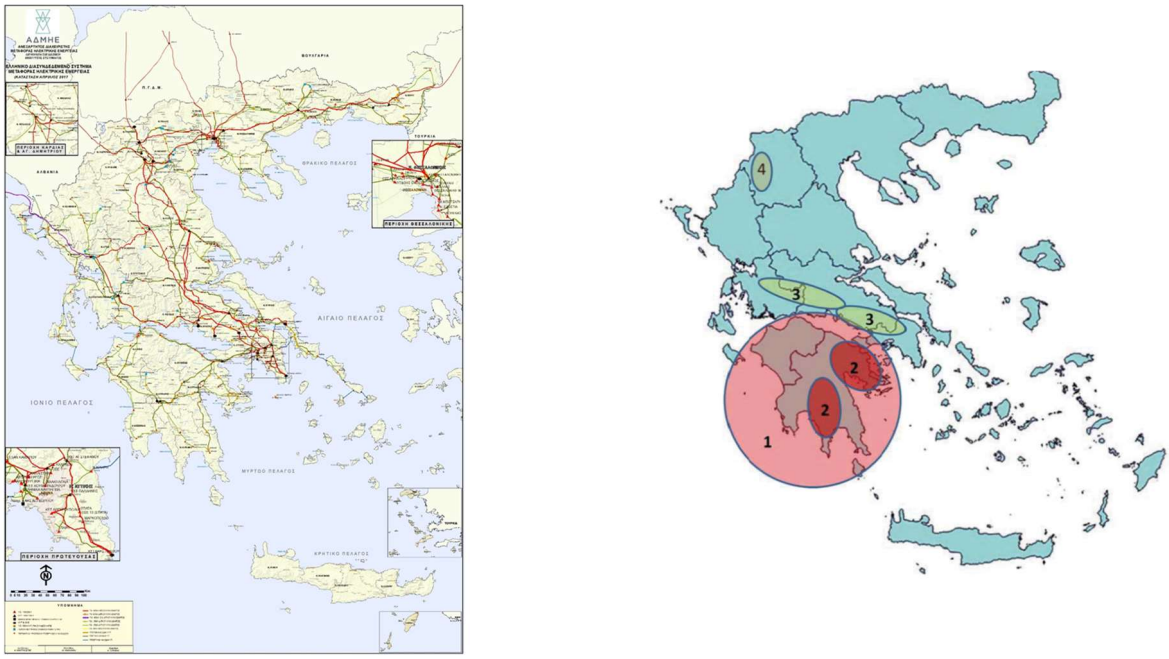
(b)

The structure of the Hellenic Electricity Transmission System in 2017 is shown in Figure 9 (a). This is highly relevant since new investments in power plants will probably be located near the high voltage

transmission lines indicated in red and also, the existing configuration of the system has created capacity bottlenecks that inhibit the interconnection of additional RES installations (see Figure 9(b)).

The Independent Power Transmission Operator has developed in 2018 a ten-year development plan which was approved by RAE, the Regulatory Agency on Energy in May 2018[29]. This was discussed earlier in section 2.1.

Figure 9 (a) Structure of the Hellenic Electricity Transmission System (HETS) in 2017; (b) saturated areas within the HETS (source: Independent Power Transmission Operator/ΑΔΜΗΕ).



(a) (b)

The official statistics (see Annex, Table 9) indicate that there were 6369 legal entities active in production and trade of electricity, but this is due to the fact that a separate legal entity is usually established for each energy producing installation (wind park, photovoltaic, small hydro, etc.). According to the National Report for 2018[30] of the Regulatory Authority for Energy (RAE), the dominant market player in Greece at the end of 2017 was the Public Power Corporation (PPC); in terms of installed capacity, PPC owned and operated about 8.9 GW of thermal and hydroelectric power plants, representing 77% of total generating capacity, excluding RES. Private producers run seven thermal power units with a total net capacity of approximately 2.6 GW as follows:

- ELPEDISON SA operated Enthess (400.3 MW) and Thisvi (410 MW), both being Gas-fired Combined Cycle Thermal Power Plants – CCGT.
- HERON SA operated Heron II (422 MW – CCGT) and Heron I (147 MW, Open Cycle Gas Turbine – OCGT).
- Mytilineos Group operated Protergia (433 MW – CCGT), Korinthos Power (434 MW – CCGT) and Alouminion (334 MW, large-scale Gas-fired Combined Heat and Power Plant – CHP).

Moreover, two additional thermal units, of 851 MW total capacity had also applied for connection including PPC's new CCGT unit Megalopoli V (811 MW). The Independent Power Transmission Operator

29 Official Government Journal, Part B', Issue 1570, 8 May 2018.

30 See http://www.rae.gr/site/file/system/docs/ActionReports/national_2018

(ADMHE) reported that by October 2019 there were more than 650 producers of electricity connected to the Hellenic Electricity Transmission System, with a total licensed generating capacity of 2.51 GW, of which 2.3 GW were wind parks and 59 MW were photovoltaic installations larger than 1 MW.

As indicated by the maps provided by RAE's geospatial information system (see Figure 28-Figure 31 in the Annex), the wind potential in South-East Greece (South Aegean Islands and Crete) is not harvested yet, but there's a considerable number of applications by investors that would address this issue if approved. Moreover, additional capacity could be created by offshore wind farms in the same regions.

According to EU data, the average electricity price in Greece's wholesale market in the second quarter of 2019 was 65.5 €/MWh, when the average of European countries was 43.3 €/MWh. This is attributed to the high cost of CO2 emissions and the limited interconnections with other EU member states. Obviously, such prices create favourable conditions for efficient producers of electricity; they are also a big competitive disadvantage for the Greek industry.

Regarding the retail market for electricity, in September 2019, after a considerable period of time where PPC's retail market share was almost stable at 74%, it declined by 2.41%, to 71.77% versus 74.18% the previous month. This 2.41% was distributed to a broad group of private suppliers, with the three major vertically integrated providers being in the top 3 places in terms of market share: Mytilineos Holdings (Protergia) taking the top spot with 5.63%, followed by Heron (5.55%) and Elpedison (4.12%). They are followed by Watt & Volt (2.30%), NRG (2.45%), Volterra (1.87%), ELTA (1.11%), Fysiko Aerio Attikis (1.13%), KEN (0.83%), Volton (0.69%) and Zenith (0.75%)[31].

eMobility

While still operating in the early stages of the diffusion curve for electric vehicles, the planning of vehicle manufacturers globally suggests that EVs will be the major option from 2024 onwards. Currently, unofficial reports indicate that only 88 electric vehicles were sold in the Greek market in 2018 and the market is expected to reach a meagre 250 by the end of 2019[32]. A recent (Sep. 2019) report by LeasePlan NV, however, estimates that there will be 72,000 EVs in Greece by 2025[33].

Although it is still too early to know which actors will drive the market for EVs and how, there is clear evidence of several attempts to address barriers to adoption. For example, BMW Hellas, the Greek authorized wholesaler of BMW cars, recently announced a joint project with NRG, an electricity retailer, to deploy 20 fast-charging stations in petrol stations across the Greek highway network. Thus, by the end of 2019 they will provide full coverage of the national highway network, and by the beginning of 2020 they will gradually develop a satisfactory coverage –apparently for BMW i-series of EVs—in the major Greek cities[34]. Similar initiatives have been taken by all major wholesalers of liquid fuels in the Greek market, as part of attempts to diversify their product portfolios.

The same LeasePlan NV report mentioned above estimates the number of public charging stations needed for Greece by 2025 to be in the range of 6,500. This will require a coordinated, decisive and timely investment in a comprehensive public charging infrastructure. Up to now, the independent market (e.g., FORTISIS and Blink Greece) and the Distribution System Operator models seem to co-exist in the Greek market.

The Athens Public Transport Organisation (OASA) is a public utility company with the mission of strategic and operational planning, co-ordination and control of the public transport carried out by (ground and underground) public transport means in the Region of Attica. OASA is the sole shareholder of transport companies O.SY. S.A. (Buses and Trolley buses) and STA.SY. S.A. (metro lines 1, 2 & 3 and Tram). Approximately 60% of the passengers carried by OASA in 2018 used one of its 1712 diesel-

31 See https://www.naftemporiki.gr/afieromata/story/1530015/anakatatakseis-sti-lianiki-reumatos-kai-fusikou-aeriou

32 See https://www.kathimerini.gr/1048325/article/epikairothta/ellada/ekponhsh-e8nikoy-sxedioy-gia-thn-hlektrokinhsh

33 See https://www.leaseplan.com/corporate/~/media/Files/L/Leaseplan/documents/news-articles/2019/leaseplan-ev-charging-index-report.pdf

34 See https://www.kathimerini.gr/1051286/article/aytokinhsh/aytokinhsh-epikairothta/strathgikh-synergasia--me-stoxo-thn-anapty3h-ths-hlektrokinhshs-sthn-ellada

powered buses (passenger-km data not available)[35] while the remaining 40% used electric-powered modes of transport. Similar data are not available for the Organisation of Urban Transportation of Thessaloniki that operates approximately 600 diesel-powered buses. Both organisations are ripe for the electrification of their remaining diesel-power fleets.

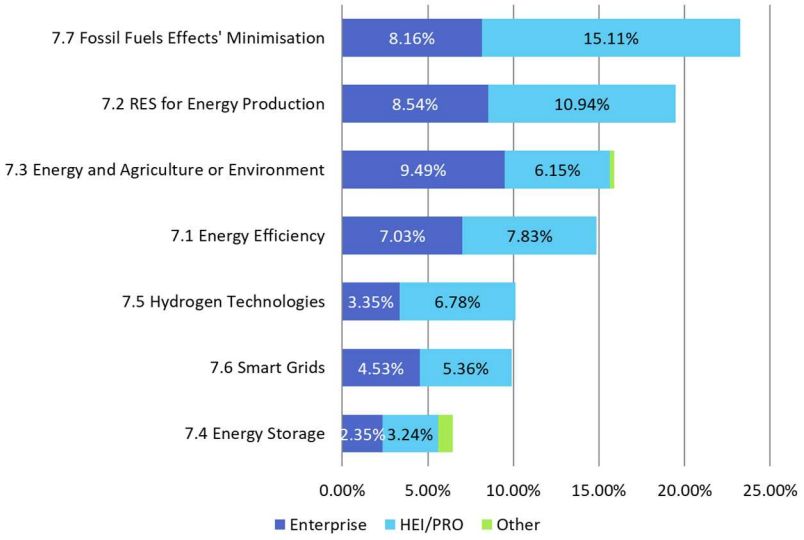
2.3.2 Research and Development

R&D&I policy

The main policy instrument for financing R&D&I in Greece in the current programming period is the "Research-Create-Innovate" programme under the national operational programme Competitiveness-Research-Innovation 2014-2020. This programme has earmarked €542mil of public expenditure to support research and innovation within the eight priorities of the national Smart Specialisation Strategy. Of these, €40.7mil (7.5%) are earmarked for research and innovation in the field of energy on the basis of similar project applications in the previous programming period.

The first call of proposals launched in 2017 was highly oversubscribed. The applications submitted under the Energy priority requested approximately €105.5mil of public expenditure and the approved projects were awarded €24.84mil of public funding. The distribution of public expenditure in the approved projects per sub-priority and type of stakeholder is shown in Figure 10. In terms of budget shares, especially minimising fossil fuels effects and producing RES rank substantially higher than hydrogen technologies, smart grids and energy storage. In addition to these projects, €1.77mil of public expenditure was approved for projects related to materials for solar cells and another €2.23mil for multifunctional materials for energy applications (conversion, storage).

Figure 10 Breakdown of the public expenditure for Energy-related R&D&I projects under the first call of "Research-Create-Innovate" programme. Source: GSRT.



A second call for this programme was launched in May 2019, with 12 new projects being approved to receive €8.94mil of public funding.

Research base

Greece has a well-established research base in the scientific fields deemed relevant for this review (see the analysis in the first column of Table 8 in the Annex, section 5.2)[36]. Aspects of scientific

[35] See http://oasa.gr/pdf/el/annualreports/ek_pe_2019.pdf

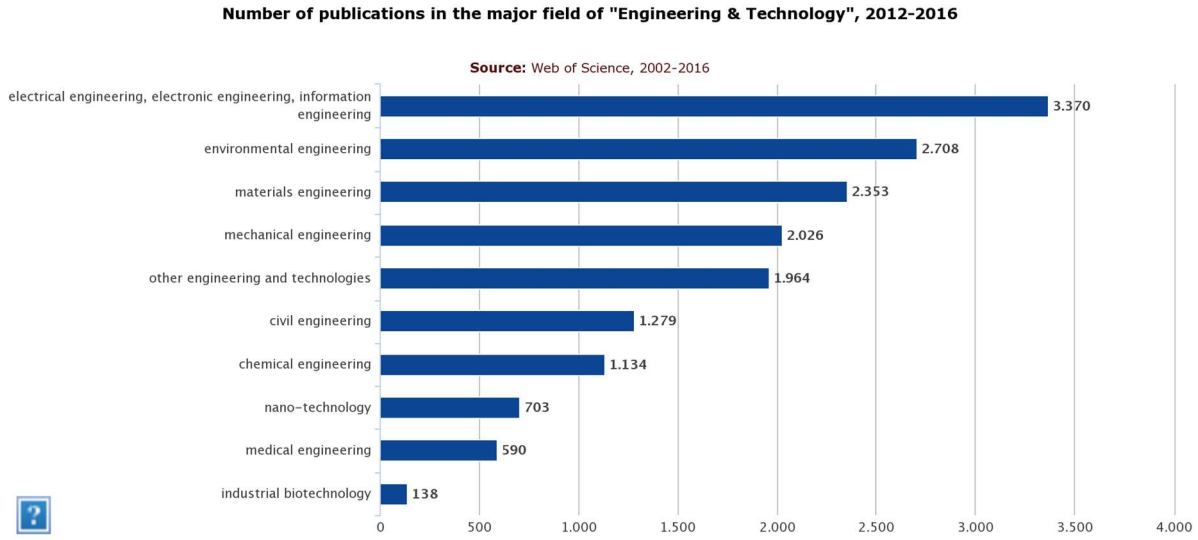
[36] TESLA's decision to establish an engineering facility in Greece is widely regarded as a vote of confidence for the skills of Greek engineers, see https://www.theguardian.com/technology/2018/mar/02/elon-musk-to-open-tesla-rd-plant-in-greece

production in terms of academic publications in the period from 2012 to 2016 for engineering and natural sciences are shown in Figure 11, and Figure 11 shows their normalized citation scores.

There are more than 25 HEIs and PROs active in these scientific fields. The best performing institutions in terms of high-quality research per scientific field in the period from 2012 to 2016 were:

- Electrical Engineering: Aristotle Univ Thessaloniki (AUTH) and National Technical University of Athens (NTUA);
- Environmental Engineering: AUTH, NTUA, Univ Patras, Technical Univ Crete (TU Crete) and NCSR Dimokritos;
- Energy and Fuels: NTUA, AUTH, Univ Patras and Centre for Research and Technology Hellas (CERTH)
- Chemical Engineering: AUTH, Univ Patras, CERTH and NCSR Dimokritos;
- Materials Engineering: Foundation for Research and Technology Hellas (FORTH), Univ Patras, Univ Ioannina, Univ Crete;
- Nanotechnology: FORTH and Univ Patras;
- Computer Science: CERTH, FORTH and NCSR Dimokritos.

Figure 11 Number of Greek publications in the subcategories of (upper graph) Engineering and Technology and (lower graph) Natural Sciences (Sahini, Malliou, Chrysomallidis, & Karampekios, 2018).



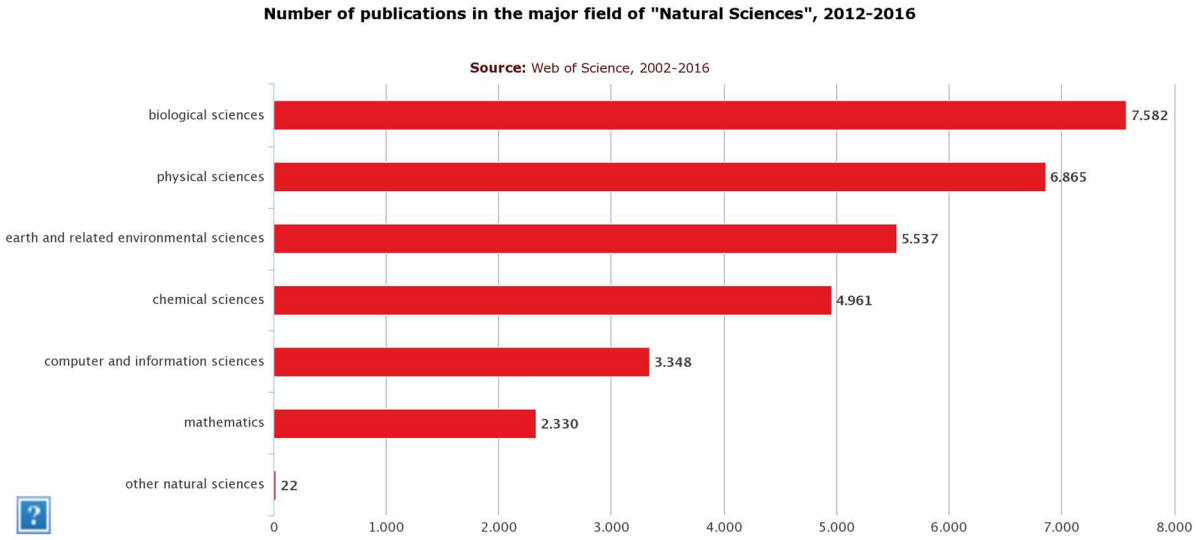


Figure 12 Publications, citations and field normalized citation score of Greek publications relative to the world, 2012-2016 (Sahini, Malliou, Chrysomallidis, & Karampekios, 2018).

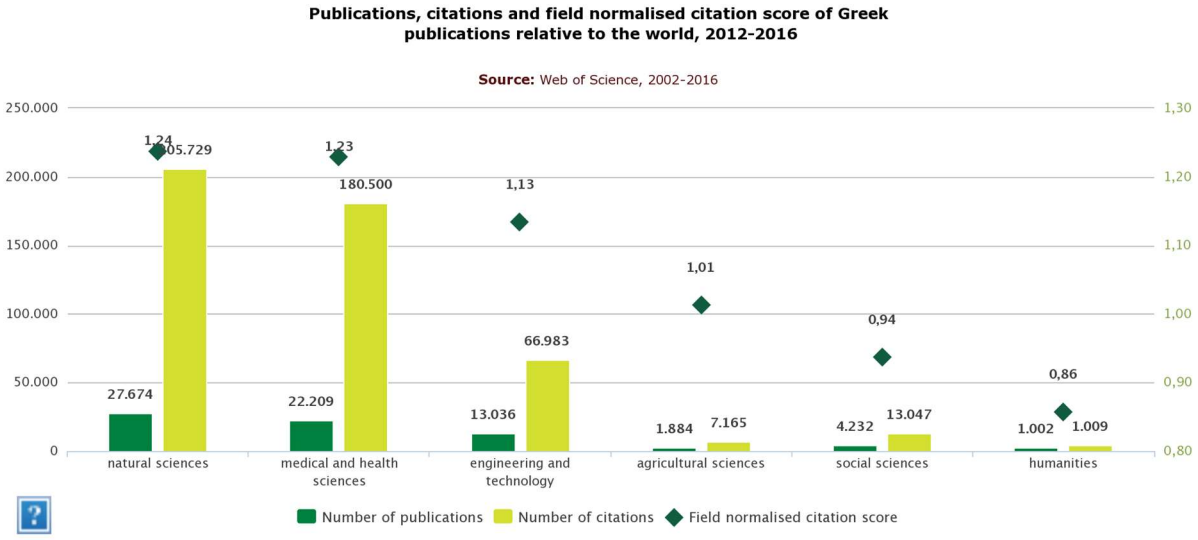
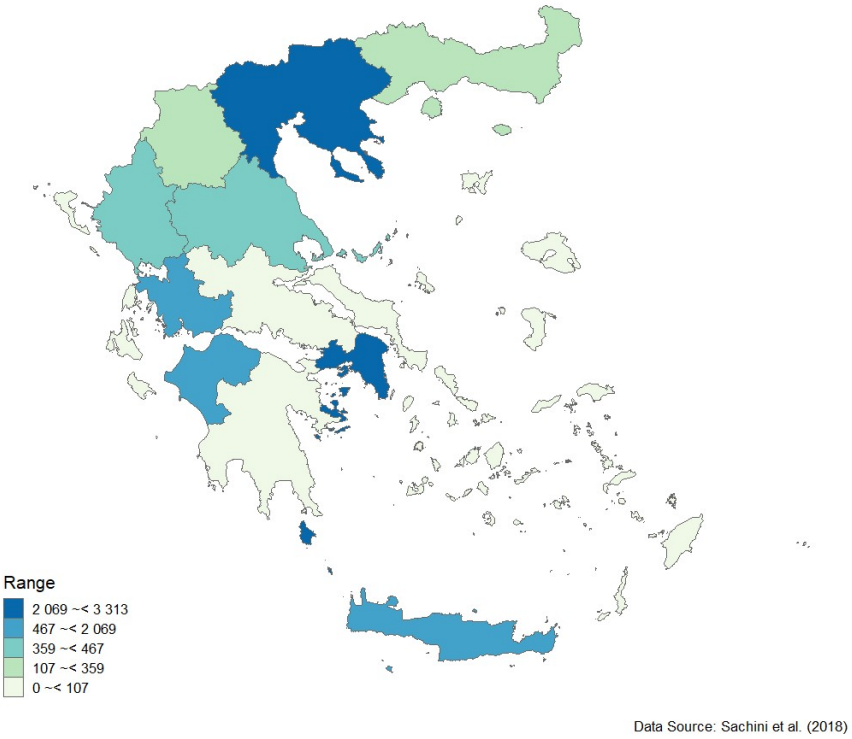


Figure 13 shows the spatial distribution of highly-cited scientific publications in all specialized thematic areas relevant to this review using a compilation of the data publicly available by the National Documentation Centre (Sahini, Malliou, Chrysomallidis, & Karampekios, 2018)[37]

37 See http://report07.metrics.ekt.gr/en/chapter2.5

Figure 13 Highly cited publications in scientific areas relevant to this review 2012-2016 per NUTS2 region.



As another proxy for competitive research in areas relevant to this report, we chose to use the highly competitive, collaborative research projects funded since 2014 either by GSRT (using ERDF funds) or by the European Commission (Horizon 2020). Figure 14 provides the institutional collaboration map for 32 H2020 projects (data provided by the National Documentation Centre), 5 National Research Infrastructures and 25 National collaborative research projects[38] (data provided by GSRT). PROs are plotted in light blue, HEIs are plotted in green and enterprises in purple. Non-Greek actors are plotted in black. Figure 15 provides the same information with only the Greek actors being visible.

[38] Call coverage: National Research Infrastructures and the first call of 'Research-Create-Innovate' or 'Ερευνώ-Δημιουργώ-Καινοτομώ' in Greek.

Figure 14 Map of collaborative research projects since 2014 (H2020 and Greek/ERDF).

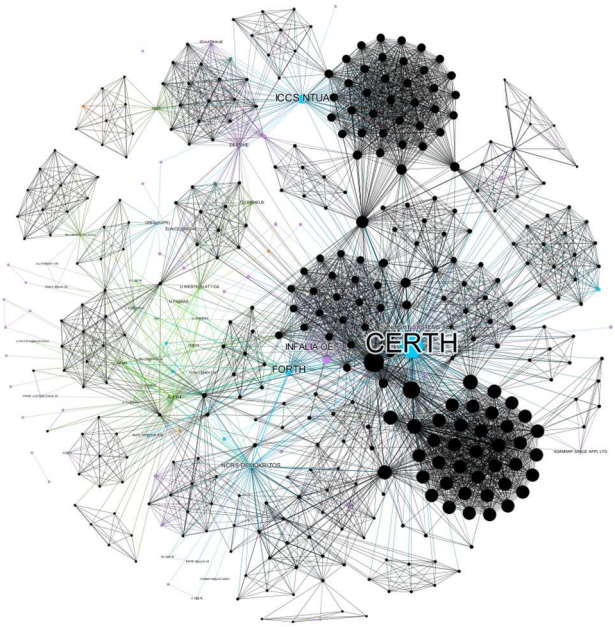
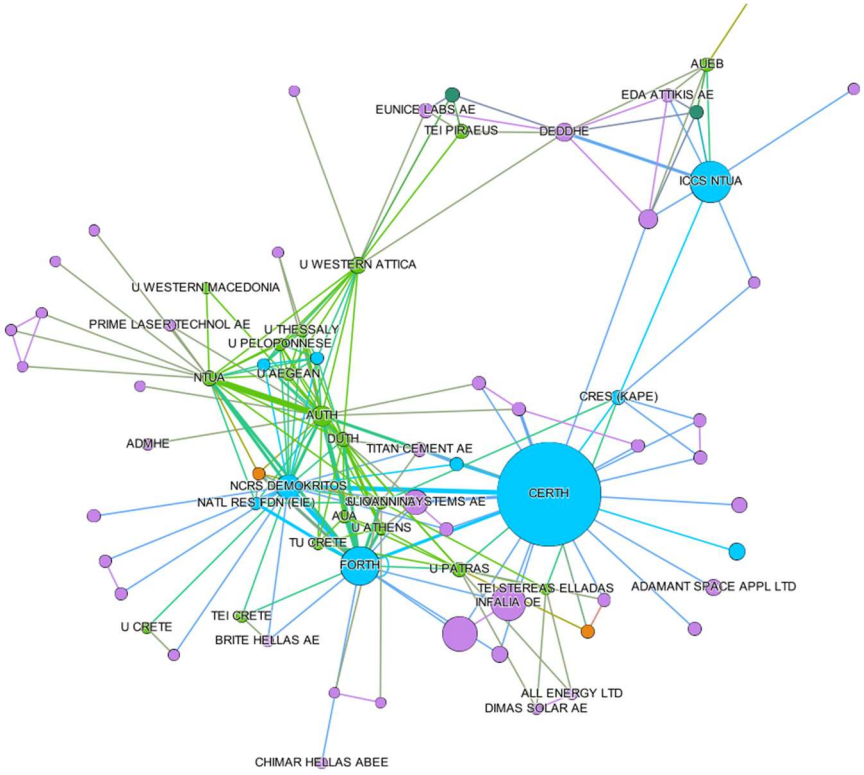


Figure 15 Map of collaborative research projects since 2014 (H2020 and Greek/ERDF). Greek actors only.

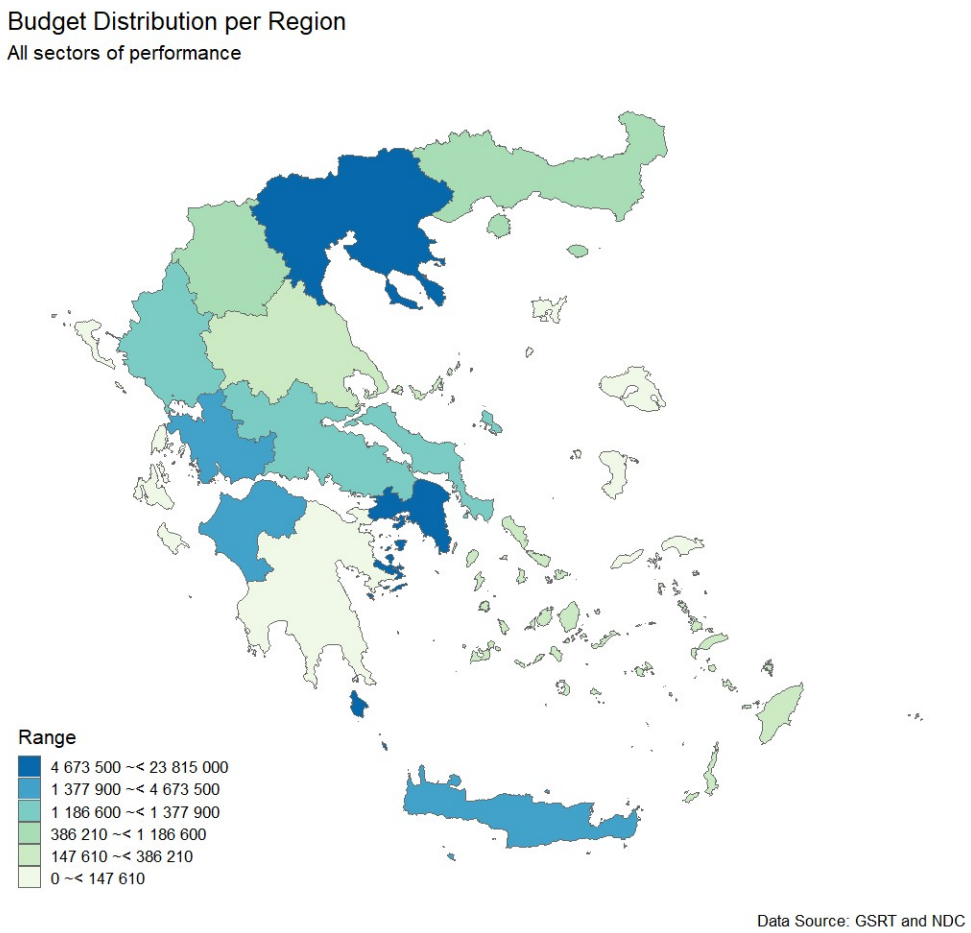


It is clear from Figure 14 that the Centre for Research and Technology Hellas (CERTH) is the actor involved in most (and most diversely composed) international projects/consortia in the country,

followed by the Institute of Communications and Computer Systems at NTUA (ICCS-NTUA), the Foundation for Research and Technology Hellas (FORTH) and the National Centre for Scientific Research "Dimokritos" (NCSR DIMOKRITOS). The HEIs in Greece have a less dominant role, characterized mainly by national projects. Finally, the business/enterprise sector, represented by 52 unique entities in our data, can be clustered into two major groups: 32 firms participating only in Greek projects, 17 firms participating only in H2020 projects and only 2 firms participating in both (SUNLIGHT SYSTEMS, HORIZON ATE). It is also worth noticing that the major business actors mentioned in Section 2.3.1 do not have any type of participation in collaborative R&D projects.

By considering Figure 16, it is clear that the loci of R&D that is relevant to this review are mainly Attica (€23.8mil; 42.4%) and Central Macedonia (€19.4mil; 34.5%), while Western Greece (€4.67mil; 8.3%) and Crete (€3.14mil; 5.6%) constitute the second tier.

Figure 16 Collaborative research projects since 2014 (H2020 and Greek/ERDF): Budget distribution per NUTS2 region.



During our fact-finding mission in Athens, it was made clear that the national R&D system as described above is not effective in commercialising research outputs. In an attempt to close this gap, one of the major industry players, Mytilineos Group, has recently launched an initiative aiming to align researchers at HEIs and PROs towards very specific urgent challenges faced by the industry[39], seeking solutions (or ideas) in the fields of algorithms and complexity, AI and forecasting models, UX and UI, energy modelling and V2G, vehicle routing and others. This list of topics should be considered in

[39] See https://www.rc.auth.gr/Announcement/Details/Item/46930?ReturnToPage=1&PageSize=3

conjunction with the research areas listed earlier in Figure 10 as an attempt to explain the absence of the key players in EU/ERDF-funded R&D programmes.

2.4 Consumption/Use

Consumption or use involves those actors that play an important role in the formation of the markets and pools of users that will drive demand for the transition. In early stages of the transition the actors who help articulate demand include public funders, early adopter communities of users. However, broader demand articulation requires 'mainstreaming' the consumption and use of the technologies and their products; key actors include industry standard- (and quality-) setters, consumer associations, producers positioned on the mass-end scale of the market, mass media etc.

Energy

The final energy consumption in Greece in 2017 was 186.7 TWh (16 054 ktoe) of which 36 TWh (3 096 ktoe or 19.3% of the final energy consumption) were consumed by Industry, 67.63 TWh (5 815 ktoe, 36.2%) by transport and 83 TWh (7 143 ktoe) by other sectors including Households (27.5%), Services (13.7%) and Agriculture/Fishing (1.9%).

Regarding transport, the total contribution of renewable energy sources in 2017 was 2.3 TWh, or 4% of the energy used in transport. Biofuels amounted for 1.9 TWh (82.6%), thus being the major RES in transport. Moreover, 5.4 GWh of RES electricity was used in road transport, and 36.2 GWh in rail transport.

Transport and Mobility

According to the World Development Indicators compiled by World Bank, the population of Greece was 10.75 mil in 2017. Urban population was 8.47 mil (78.7%), of which 3.16 mil lived in urban agglomerations of more than 1 mil[40]. The number of passenger cars registered by the end of 2016 were, according to Eurostat, 5.16 mil (479 per thousand inhabitants), of which 2.83 mil in the Region of Attica (752 per thousand inhabitants). The number of new passenger car registrations in 2017 was, according to the Hellenic Association of Motor Vehicle Importers and Representatives, 88 thousand, and 103 thousand in 2018. The same figures for motorcycles were 29 and 33 thousand, respectively. New registrations of passenger cars by type of motor energy are not reported[41]. Although passenger-kms are not directly reported for Greece, Eurostat estimates that 82.5% of the total in 2017 was carried out by passenger car, 16.6% by motor coaches, buses and trolley buses and only 0.9 % by train. Moreover, 98.2% of ton-kilometres of freight transport has moved on roads in the same year.

Agriculture

Although agriculture consumes only 1.9% of the final energy consumption in Greece, there is plenty of opportunities for introducing RES and improving energy efficiency. Typical application areas might include using RES for powering water pumps, photovoltaics in greenhouses – of which a demo by NCSR Demokritos was showcased during our fact-finding mission, and in a wider sense, pumped hydro plants for both energy storage and irrigation. Moreover, agricultural and forestry waste can be used to produce energy from biomass and thus introduce circular economy approaches to RES production.

Shipping

During our fact-finding mission in Greece, the Electric Boat Association brought to our attention that electrically powered vessels are prohibited by law. Although the rationale for this is unclear, as we have already indicated in Chapter 1, there's a relatively strong industry in Greece for leisure boats

[40] This refers to the metropolitan area around Athens. Thessaloniki's urban area had a population of 824,000 in 2011, falling short of the 1 mil threshold.

[41] Unofficial data suggest that 88 EVs were registered in Greece in 2018, while for 2019 the market is expected to be 250. (Source: https://www.kathimerini.gr/1048325/article/epikairothta/ellada/ekponhsh-e8nikoy-sxedioy-gia-thn-hlektrokinhsh)

and similar vessels that usually cover short distances. Introducing electric powertrains would be possible next step for this industry.

Defence

Our fact-finding mission in Athens indicated that the Ministry of Defence can be a significant market adopter of innovations within the scope of this review, using either the Commercial Off The Shelf (COTS) or Military Off The Shelf (MOTS) approaches. By virtue of its single-point procurement schemes in addition to its large-scale infrastructure usage in the country, MoD can become an important public-level early adopter. Indeed, according to the responses in our interviews, a programme for upgrading energy efficiency in military installations is under development and aggregated demand for electric vehicles for auxiliary support services (i.e. buses) is under consideration. Of course, these procurements should be managed in tandem with the Public Procurement Authority (*Ενιαία Αρχή Προμηθειών),* something that could create economies of scale and boost demand under wider public procurement schemes. However, the scope of applications examined in the framework of this review did not receive any attention within the last version of the National Defence Industrial Strategy[42].

2.4.1 Consumer perceptions towards Renewable Energy Sources

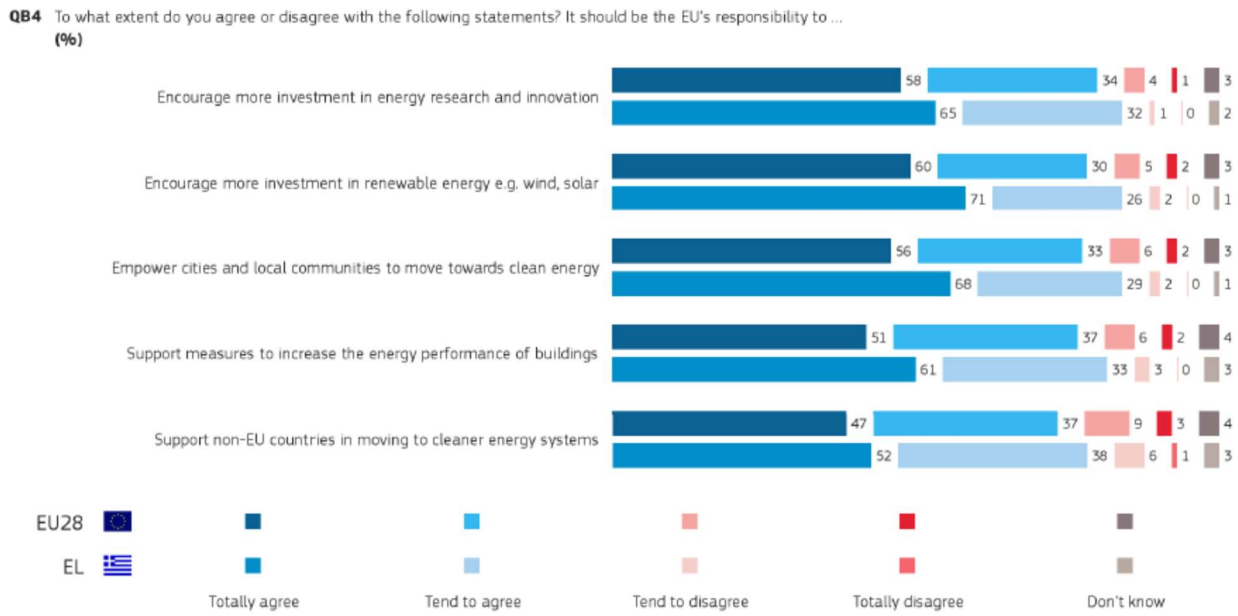
The results of a recent Eurobarometer survey[43] carried out in May 2019 suggest that the majority of Europeans do not really know the exact aims of the EU Energy Policy, but in terms of expectations from it, clearer patterns tend to appear. Nearly half of the respondents say that the EU should invest in and develop clean energy technologies, while a third say that EU should step up international efforts to reduce the impact of energy on climate change. Just under four in ten responders said they believe the EU should focus on ensuring energy costs are as low as possible in the next ten years. Younger and more educated responders are more interested in environmental issues connected with energy, while those who are older and less educated raise issues associated with affordability.

Greek participants seem to be more supportive than the EU average for all options related to ensuring access to clean energy (see Figure 17).

42 See http://www.gdaee.mil.gr/sites/default/files/EABS_1.pdf

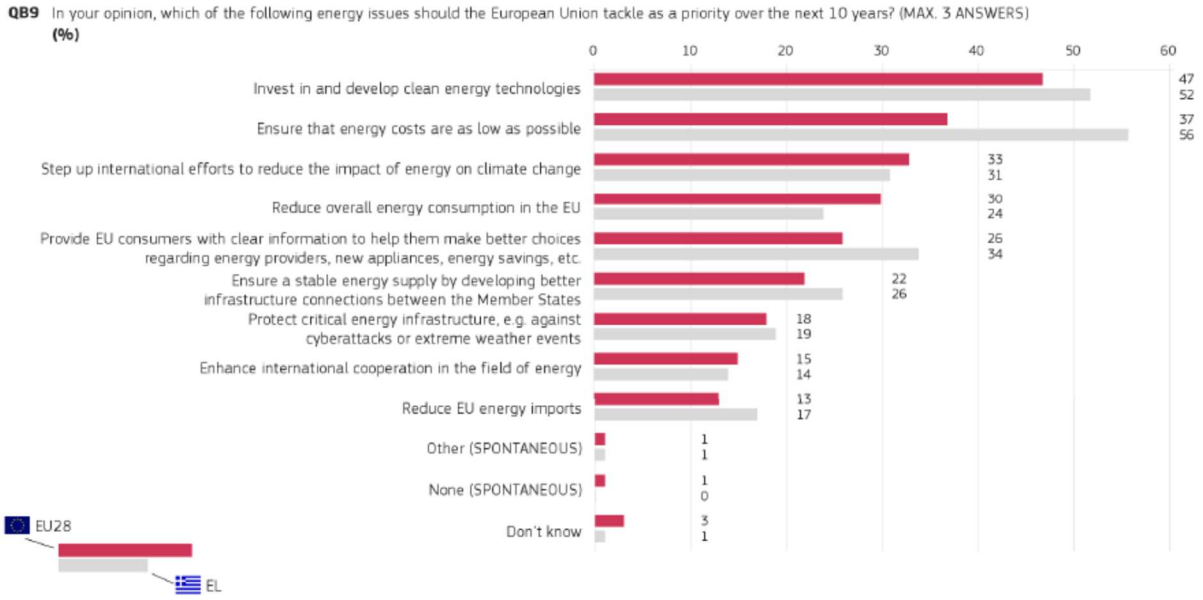
43 https://ec.europa.eu/commfrontoffice/publicopinion/index.cfm/ResultDoc/download/DocumentKy/87730

Figure 17 Responses to questions on ensuring access to clean energy: EU28 vs EL.



Greek respondents seem to offer a greater support than the EU average to the idea that the EU should invest and develop clean energy technologies as a priority. Greek respondents are particularly concerned about the affordability of energy, mentioning this as their primary issue in 56% of the responses (see Figure 18). The same concern seems to be of primary importance to Latvia (60%), Lithuania (58%), Portugal (56%) and Cyprus (54%).

Figure 18 Responses on the EU energy priorities for the next ten years.



From the above, one can derive that the key messages of a communication campaign to increase the acceptance of RES among the general population in Greece might include affordability issues, the effects of CO_2 emissions in the current cost of energy and the viable, in economic sense, alternatives to lignite-produced electricity. Moreover, although the reported negative attitudes in investing in

renewable energy are very low (2% in the second question in **Figure 17**), there are many recent cases in Greece of highly localised protests against wind power energy projects[44]. To change this mentality, one must address them directly by providing incontrovertible international evidence on the positive environmental impact of such installations and engage directly with local stakeholders to discover ways of introducing RES that also yield local benefits.

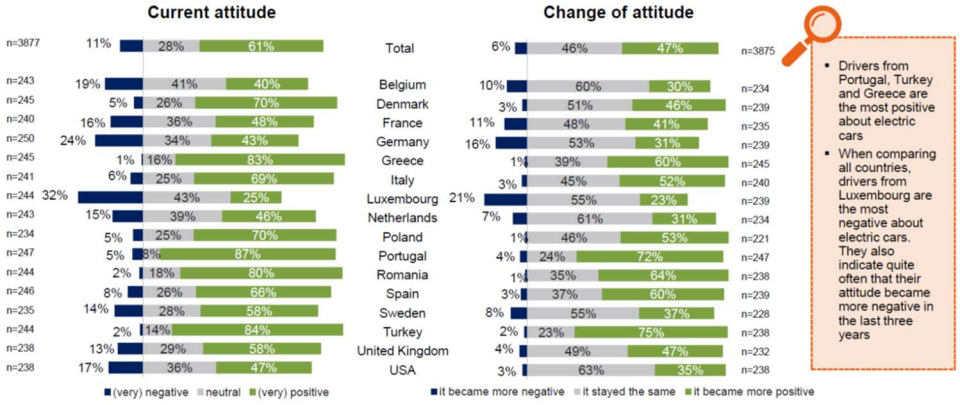
2.4.2 Consumer perceptions towards Electric Vehicles

According to a survey[45] commissioned by LeasePlan NV, a car rental company and conducted across 16 countries in 2019, a surge in positive attitude towards electric driving is recorded, with 61% of respondents indicating that they view zero-emission electric driving favourably. Nearly half of all surveyed said that their opinion towards electric driving has favourably improved over the past three years. In Greece, as shown in Figure 19, the attitude towards electric cars is positive or very positive in 83% of the sample, while positive change of attitude over the past three years is at 60%. Both values are well above the overall sample means.

[44] See for example https://www.ert.gr/perifereiakoi-stathmoi/tripoli/monemvasia-sygkentrosi-diamartyrias-gia-ta-aiolika-parka-kai-ta-diktya-ypsilis-tasis/, http://stopaiolika.blogspot.com/, http://www.ikarystos.gr/2019/10/blog-post_14.html, and https://www.agriniopress.gr/aiolika-agrafa-triimero/.

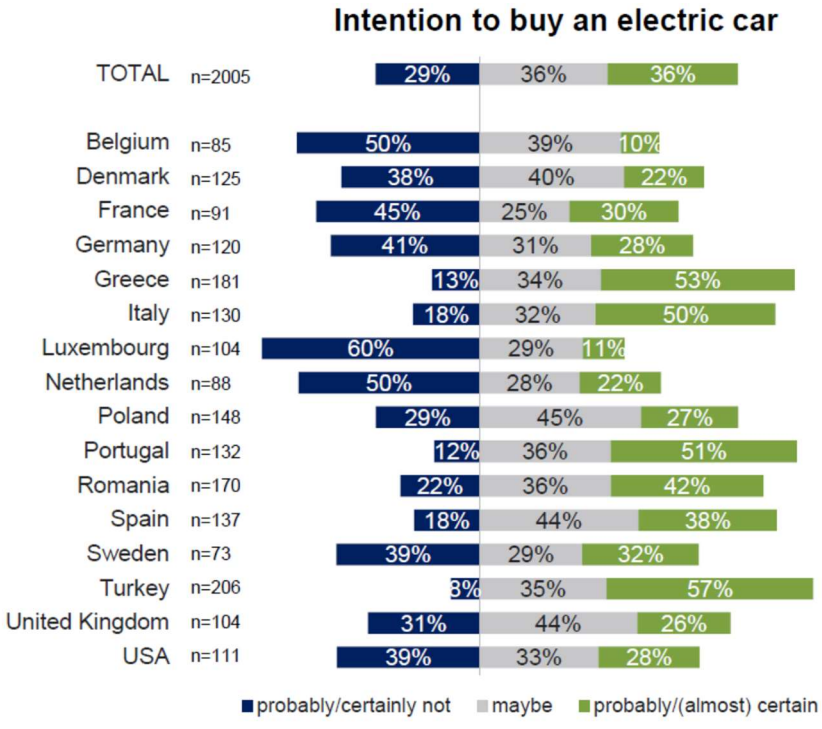
[45] Available online at https://insights.leaseplan.co.uk/wp-content/uploads/2019/10/LeasePlan-Global-mobility-monitor-2019-evs-and-sustainability.pdf

Figure 19 Attitudes towards electric cars (source: LeasePlan Mobility Monitor 2019)



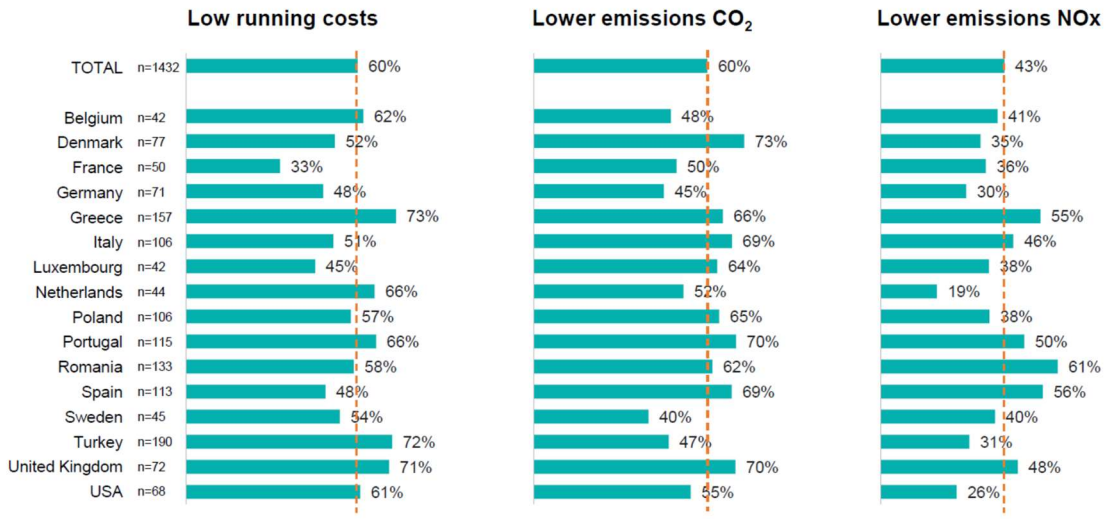
On average, across countries, more than one in three respondents planning to buy a car in the next five years declared their intent to buy an electric vehicle; in Greece, this was 53% (see Figure 20). Similar, and slightly higher intentions are recorded among those planning on leasing a car in the next 5 years.

Figure 20 Intention to buy an electric car in the next five years. (Source: LeasePlan Mobility Monitor 2019)



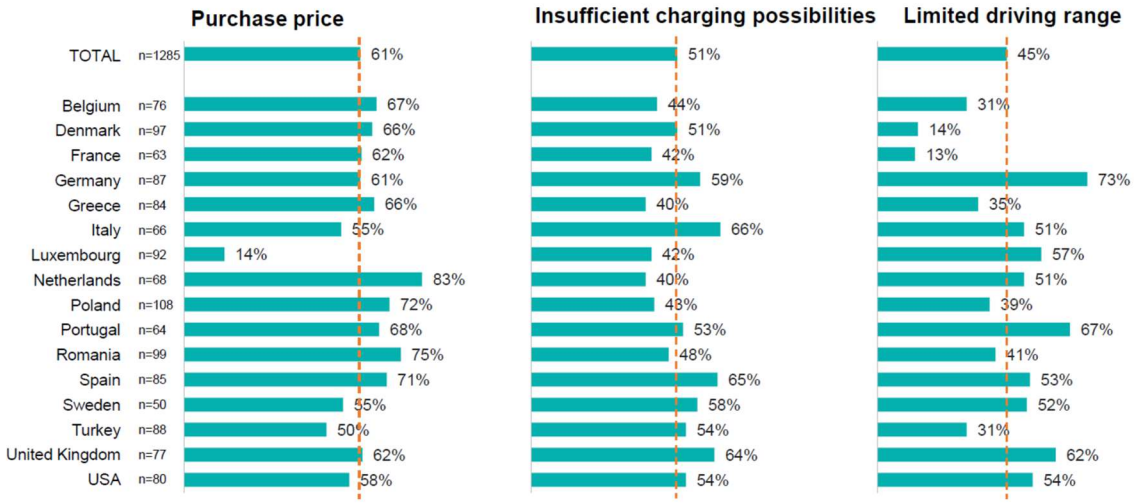
According to the respondents, the benefits of electric driving can be categorised as follows: EVs contribute to fighting climate change through lower CO2 emissions (according to 60% of those planning to go electric in the next five years); help improve air quality in towns and cities through lower NOX emissions (43%); and have an overall lower running cost (60%). For Greeks, as shown in Figure 21, low running costs is the major issue that will drive adoption.

Figure 21 Top 3 reasons to buy an electric car in the next five years (source: LeasePlan Mobility Monitor 2019)



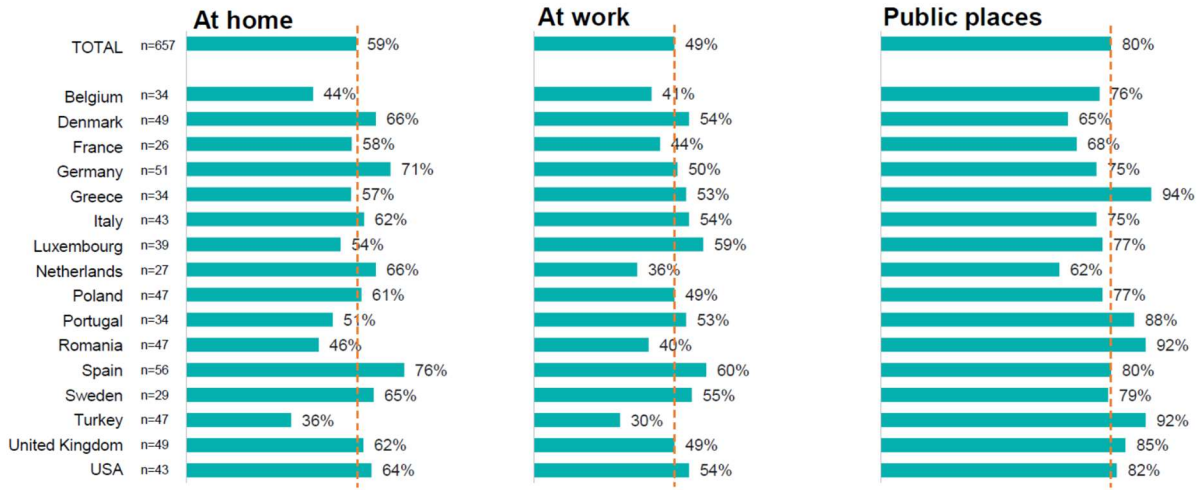
While the majority of people surveyed view electric vehicles favourably, practical concerns surrounding infrastructure present an active barrier to entry. Specifically, 51% of those planning to buy a car in the next 5 years cited insufficient charging infrastructure as preventing them from choosing EV, while limited driving range, or so called "range anxiety", was the reason another 45% said they would not go electric. In Greece, as shown in Figure 22, the main barrier to the adoption of EVs is *purchase price*.

Figure 22 Top 3 reasons not to buy an electric car in the next five years (source: LeasePlan Mobility Monitor 2019)



Eight in ten respondents planning to buy a car in the next five years, but not an electric car because of the insufficient charging possibilities, said that insufficient charging possibilities at public places is the key issue for their decision. As shown in Figure 23, 94% of the Greeks in this sample agree.

Figure 23 Perceptions for insufficient charging possibilities by locus (source: LeasePlan Mobility Monitor 2019).



Returning to the topic of EV prices, although most analysts[46] predict that they will reach parity with those of conventional vehicles within five years, a new report from the MIT Energy Initiative (MIT Energy Initiative, 2019) warns that EVs may never reach the same retail price so long as they rely on lithium-ion batteries, the energy storage technology that powers most of today's consumer electronics. According to this report, it is likely to take another decade just to eliminate the difference in the lifetime costs between the vehicle categories, which factors in the higher fuel and maintenance expenses of standard cars and trucks. These findings sharply contradict those of other research groups, which have concluded that electric vehicles could achieve price parity with gas-powered ones in the next five years (or sooner). The lingering price difference predicted by the MIT report could stunt the transition to lower-emission vehicles, *requiring governments to extend subsidies or enact stricter mandates to achieve the same adoption of EVs and cuts in climate pollution.*

The results above indicate a latent demand for EVs in the Greek market. Adoption can be accelerated primarily by means of tax policy[47] and / or financial motives to replace older-technology cars and by supporting the rapid expansion of public charging stations.

[46] See https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/making-electric-vehicles-profitable; https://about.bnef.com/blog/electric-cars-reach-price-parity-2025/; https://www2.deloitte.com/uk/en/pages/press-releases/articles/21-million-more-electric-vehicles-expected-worldwide-by-2030.html; https://www.carbonbrief.org/factcheck-how-electric-vehicles-help-to-tackle-climate-change; https://cleantechnica.com/2019/12/04/powering-the-ev-revolution-battery-packs-now-at-156-kwh-13-lower-than-2018-finds-bnef/

[47] See https://theicct.org/sites/default/files/publications/EU_vehicle_taxation_Report_20181214_0.pdf

2.5 SWOT analysis and concluding remarks

2.5.1 Planning and orientation

Table 4 summarises our previous discussion on planning and orientation in the form of a SWOT matrix.

Table 4 SWOT Analysis: Planning and Orientation

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
NECP has high ambitions Ministry of Investments coordinates EU Structural Funds and consults widely within government RIS3, though the EDP, also involved thematic ministries in agriculture, energy, transport Pockets of visionary intellectual leadership in academia Creation of new 'Digital ministry' may spur interdepartmental coordination.	Policy investments in energy and transport do not follow an industrial development logic: rather spasmodic responses to chronic and pervasive under provision of public infrastructure No clear overall framework for coordination for the range of portfolios and instruments impinging on industrial policy Electric mobility plan is not holistic and still not in place. Associations/federations of industry players have little institutional capacity to influence policy Inability to scale up successful innovative (RES) projects Resistance, frustration and disastrous delay of the transition by powerful energy system incumbents Need for ministries to take responsibility might go against cooperation Ministry of Defence can play a role in spurring adoption, but is poorly connected to other ministries	EU funding can provide long-term financing and orientation, as part of future RIS3 City councils can play a leading role in orchestrating the electrification of mobility, motivated by improvements in air quality, noise levels and human health, and opportunities electrification offers for urban regeneration Especially on the islands there are some successful experiences with demonstrator experiments; pilot findings might be exportable to other non-interconnected islands	Other players (countries / firms) might respond quicker to market opportunities, set the direction and reap the benefits Greek investments in electricity and EV infrastructure might be incompatible with global direction of electrification of mobility

The actionable strategies that can be considered from the above include:

- Strengths–Opportunities. Embrace the opportunity of the next programming period and the budgets earmarked through ESIF and the InvestEU programme, and via the Just Transition Mechanism, to put the transition in the policy agenda and make use of the tested consultation and coordination mechanisms that are currently in place within agencies of the Ministry of Development.
- Strengths-Threats. Institutionalise advisory boards comprising visionary leaders out of the government sector and boundary spanners and have these cross-check planning.
- Weaknesses-Opportunities. Consider finding new uses of successful pilot projects with considerable national value-added and provide the necessary means for scale-up and replication.
- Weaknesses-Threats. Delegate non-overlapping responsibilities and time-bound policy targets among ministries, improve coordination and monitor performance regularly.

2.5.2 Resource mobilisation

Table 5 summarises our previous discussion on resource mobilisation in the form of a SWOT matrix.

Table 5 SWOT Analysis: Resource mobilisation

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
Finance: ESIF and other (structural) funds, part of which are earmarked for sustainability Strong focus on cutting barriers to FDI by current government Renewables investments by Hellenic Petroleum and other big players Increasing trend on R&D investments, esp. BERD	*Finance:* Many barriers to private investment: cost of capital, regulation, rule of law. Historical difficulties in attracting FDI Need to service excessively high external debt constrain public investments Public transport corporations financially constrained Low share of energy in R&D and innovation budgets; incongruity between demand and public research spending	International abundance of capital ready to be invested Equifund (equity funding for knowledge-intensive businesses) New EU financial instruments (e.g. from EIB) Leveraging private investments by utilizing EU funding in effective policy schemes	All other EU countries are looking for finance as well; investors will be picky
Human resources: High-quality tertiary graduates and good ICT skills	*Human resources:* Chronic misalignment of education system with market needs Weak and out of date vocational skills; system for training is underperforming In-firm training is lacking	EU promotion of public procurement of innovation is gaining attention, e.g. via Digital innovation Hub of Ministry of Investment	

The actionable strategies that can be considered from the above include:

- Strengths–Opportunities. Accelerate efforts to remove barriers to FDI. Make effective use of all available funding sources by implementing policy instruments that are tailored to the structure and the needs of the RES market.
- Strengths-Threats. Promote the availability of high-quality graduates and communicate successful RES investments.
- Weaknesses-Opportunities. Limit the scope of ESIF-funded public R&D spending in the field energy to fewer priority areas having higher prospects of value added at the national level. Support and extend the ecosystem that provides ancillary services to the main actors. Provide the blue-collar workers in the sector with the necessary skills.
- Weaknesses-Threats. Organize vocational training via collaborations between educational institutes and local firms (with employment opportunities), in order to avoid the brain-drain of students and employees with future-proof skills demanded also in other countries.

2.5.3 Production (knowledge, goods/services)

Table 6 summarises our previous discussion on production in the form of a SWOT matrix.

Table 6 SWOT Analysis: Production

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
Local presence of rare raw materials useful for magnets and EV production	Battery industry dominated by single mayor player	Relatively high energy prices invite for local sustainable energy production	Western Macedonia faces employment decline and energy security issues (purchasing gas) due to phasing out lignite
Strong science base in electrical and environmental engineering	PRO's dominate research (and generate few start-ups); little involvement of firms	Law on energy communities	Business leaving the region (country) might destruct entire value chains
Battery recycling policies / systems in place	Mostly local recollection of batteries, recycling occurs elsewhere	Potential for biomass-based electricity production and supporting rural communities	Loss of domestic energy production capabilities (and associated energy ecosystem) as a result of possible failure of PPC
Presence of various local renewables companies	Energy production/trade market dominated by large incumbent (PPC), in dire financial situation, unclear role in sustainability transition	Connecting major islands to national grid can create new capacity for RES (wind); the unconnected small islands can create autonomous local RES production facilities	Greek knowledge production system is unable to follow/apply developments at the European level
Presence of substantial ICT sector	Relatively high energy price hampers industrial activity		
	Regulation: obstacles to innovation on energy distribution; regulatory instability hampers investment		
	Lack of manufacturing base (and diverse capabilities): linked to inability to sustain scale economies		
	Business networks around batteries, RES and transport seem weak		

The actionable strategies that can be considered from the above include:

- Strengths–Opportunities. In addition to existing support schemes for RES production, incentivise local RES production (incl. wind, solar, biomass), storage and consumption schemes that create synergies with other sectors of the economy.
- Strengths-Threats. Use appropriate policy measures to support enterprises in regions affected by the transition in diversifying their production and address new markets, including the local provision of relevant R&D capabilities. Consider a mission-oriented approach for public R&D in the field of energy.
- Weaknesses-Opportunities. Accelerate the reforms towards a more competitive energy market and provide the necessary infrastructure for extending RES production to include the Aegean islands.
- Weaknesses-Threats. Incentivise the creation of business networks around RES, storage and transport in the regions most affected by the transition.

2.5.4 Consumption

Table 7 summarises our earlier discussion on consumption in the form of a SWOT matrix.

Table 7 SWOT Analysis: Consumption

STRENGTHS	*WEAKNESSES*	*OPPORTUNITIES*	*THREATS*
Recent surge in positive attitude towards electric driving; relatively high willingness to buy or lease EV (>50%) Consumer familiarity with solar energy due to widespread and early adoption of solar hot water	EV adoption hampered by worries about purchase price, running costs, infrastructure (charging facilities) and range anxiety. Protests against wind power energy projects Little public appetite for sustainable energy (incl. NIMBY for local RES); affordability is the major issue Large average age of cars (low replacement rate) hampers adoption of new cars	Potential for EV usage in (public) niches like ambulances, military, universities Increasingly also tourists with EVs ask for charging facilities; this might break catch22-situation Fleet shortages and lack of maintenance (= investment shortage in existing system) in public transport, provides window for leapfrogging directly to electric alternatives. Islands as archetypical niches, in terms of infrastructure, demands, culture (local communities). Demands for EV mobility range are limited.	EV price parity foreseen for 2025 may in fact take longer to happen

The actionable strategies that can be considered from the above include:

- Strengths–Opportunities. Build on the increased consumer interest towards electric vehicles to accelerate the transition by reducing barriers to adoption in a cost-effective manner.
- Strengths-Threats. Search for EV application domains in which the still relatively high price (due to lithium-ion batteries) is not a major issue, for instance in public transport settings; these 'niches' can be used to install charging infrastructures and achieve EV adoption scales that can help lowering overall switching costs for potential private EV consumers.
- Weaknesses-Opportunities.
  - Support the electrification of public transport in metropolitan areas and the (targeted) replacement of passenger cars to achieve, among others, environmental and health benefits.
  - Communicate to the general population the benefits of RES from the perspectives of energy cost, environmental, health and energy security.
- Weaknesses-Threats. Consider subsidizing the purchase or use of EV (e.g. by targeting the vehicles, infrastructure, or electricity) on the short term.

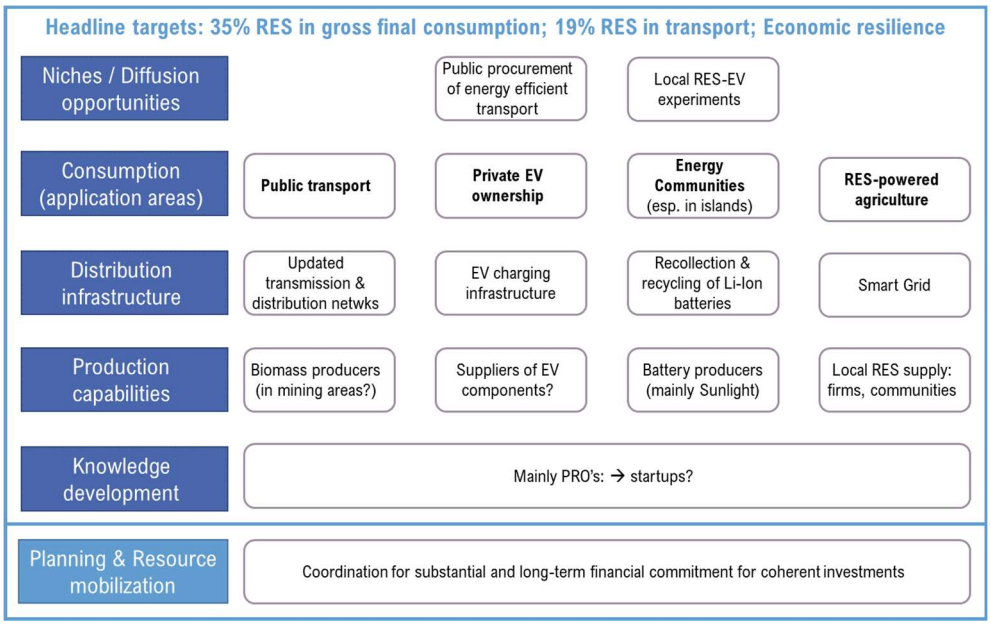
2.5.5 Concluding remarks

This chapter provided information on the current state of the four central pillars in Greece's production-consumption system relevant for its industrial transition.

Overall, the image is that while the NECP presents promising opportunities for taking new directions in the production and application of RES, there are still many challenges on the road ahead. The planning part of the system can draw on distributed expertise but requires more coordination to bring all essential pieces of knowledge and assets together. The same holds for resource mobilisation; plenty of funding opportunities exist, especially from the side of the European Commission and global financial markets, yet they are insufficiently utilized for backing long-term and coherent visions on how to boost complementary investments in RES production, distribution and usage. On the production side one can find competent stakeholders, especially when it comes to research conducted by PRO's. Still, there are structural difficulties with turning scientific competences in significant amounts of successful start-ups. Looking at the industrial tissue in general, there is a lack in number and variety of industry players able to contribute substantially to imagining and realizing an industrial transition meeting both sustainability and economic objectives. The presence of productive capabilities is comparatively low. In as far the emergence of a strong industrial base is depending on local demand, there currently is little public interest for RES usage. On the other hand, openness to electric mobility is surging. An alternative promising application area of RES (and battery technology) would be public transport provided in e.g. the large cities. Also, the issues non-interconnected islands face with traditional energy supply present a possibility for switching directly to a RES-based production and consumption model.

For an industrial transition to succeed, the key is to leverage such opportunities by linking them to the particular strengths encountered in the Greek system. Based on the system mapping in this chapter and the input retrieved via the fact-finding mission, a tentative SWOT analysis was conducted for each of the system components and appropriate strategies have been selected. Putting all the strengths, weaknesses, opportunities and threats together provides a first impression of topics relevant to consider when envisaging concrete industrial transition pathways. The topics and the system components they belong to are shown in Figure 24. How these 'ingredients' can together feature in a recipe for success is the topic of the next chapter.

Figure 24 Topics with high relevance for constructing industrial transition paths.



3 The desired state of the system

Actors, mechanisms, relations and framework conditions in the desired state of the system

Searching for synergies

Besides forces like globalisation and the rise of new technologies, e.g. in the fields of batteries, smart grids and EV charging, also the adoption of the NECP and the desire to diversify the economy (especially in Western Macedonia) have led to new challenges as well as opportunities for Greece. Some of these are recognised in formal strategies, whereas other deliberations mostly exist in the minds of relevant stakeholders. As noted at the end of the previous chapter, and summarised in Figure 24, these strategic deliberations concern topics such as the electrification of transport (incl. trains, trams, buses and ships), private electric vehicle (EV) ownership and use, and the enhanced production and use of renewable energy sources (e.g. via local energy communities).

The objective of this POINT review is not to make statements on how policies for some of these individual domains can be improved. Instead, the review focuses on identifying and exploiting promising opportunities *at the intersection* of different explicitly or implicitly pursued developments. While it is only natural for policy systems to target policy domains one-by-one, there can be important synergies in linking these domains together. A fundamental characteristic of transitions, including industrial transitions, is that they require changes throughout many elements of a socio-economic or production-consumption system. Chapter 2 already described the current state of affairs for four functions in the production-consumption system relevant for meeting Greece's headline targets for RES use. As transitions are held back by inertia in the current system, the challenge is to align system changes in such a way that they leverage each other. Indeed, the impact of interventions can sometimes be amplified by joint actions that facilitate coupling between industries falling under disparate policy portfolios, such as to develop new profitable niches in agriculture by promoting RES, or by using RES surpluses to lower the costs for energy intensive industries (such as cement), or by kick starting an industry in waste management and recycling by tightening environmental regulation and enforcement. This means that, while necessarily being experimental, transitions also need extensive coordination and coherence across government.

Coherent transition paths

In the case of Greece, possible ingredients of at least the technological side of a coherent transition path could be, for instance:

- The coupling of EV ownership and use to renewable energy production and storage (including batteries) and smart grids, with a complementary emphasis on investments by households.
- The coupling of growing photovoltaic and wind energy production to both hydroelectric pumped storage facilities and stationary grid-scale battery storage solutions, to solve intermittency and permit a fully renewable energy mix.
- The coupling of clean ports (uniting RES use and waste recycling) to clean shipping (running at least partially on clean energy, and also playing a role in collecting waste).
- The coupling of green islands and clean shipping in the form of electrified vessels including ferries.
- The coupling of electrified urban transport, public transport, last mile logistics and growing EV ownership and use, enabled by a grid containing sufficient capacity, charging stations and embedded smartness.
- The coupling of waste management at an industrial scale and renewable energy production.
- The coupling of green technology, waste management (reuse, recycling, or disposal of e.g. lithium batteries, photovoltaics and wind turbines) to environmental remediation and

renewable energy production in Western-Macedonia (building on regional strengths in construction, metal-works engineering and energy-intensive industries).

To spur the discovery of synergies between such paths (i.e. synergies between technologies and/or the systems around them), this chapter describes what obstacles currently hamper the exploration and exploitation of complementarities between different parallel developments. The findings, again structured according to the four production-consumption system functions of Chapter 2, are retrieved from interviews probing into the success and fail factors for developments like the ones listed above. The analysis also includes a discussion of opportunities for overcoming identified obstacles. Many of the suggestions made on this account are a reflection of input provided by contacted stakeholders. By outlining the desired state of a system beneficial for unleashing an industrial transition, this chapter provides a basis for selecting measures to accelerate the transition (see Chapter 4).

3.1 Planning

Holistic strategic planning

To capture synergies, it is important to engage in holistic strategic planning, with special attention to complementarities between transition paths that can reinforce each other. At the moment, already some structures are in place that help to ensure alignment between policies. These include **executive units** for linking various ministries, as well as **monitoring committees** that oversee developments affecting multiple policy domains.

One clear example of a coordinated effort is the **joint ministerial committee** for electric mobility, under the responsibility of the Ministry of Energy & Environment. Different ministries collaborate to orchestrate efforts for driving the adoption of EV use. As the EV adoption projections presented in the NECP seem to be reasonably ambitious (see section 6.1), the presence of structures for **programmatic coordination** can be crucial for meeting the transition objectives. A positive development in this respect is the inclusion of the Association of Greek Regions in the new Green Pact for Electric Mobility. However, the participating ministries unite forces for the EV adoption objective only; there is no particular attention for industrial development, economic growth and employment opportunities, or for the possibilities of linking up with developments in other policy domains or sectors such as reuse and recycling, electrification of ports, shipping, islands, and RES generation/storage by households. This might be due to the trade-off of using the momentum of the NECP and focusing policies on one single priority, versus looking for synergies, which inherently require coordination efforts and time. Still, in the longer run it is likely that desirable changes can only gather pace if the measures are backed by relevant stakeholders, like representatives of the municipalities or regions in which charging stations need to be deployed, or the institutes required to develop training schemes for people to have the skills for implementing new solutions. This would call for establishing multi-stakeholder **working groups** also involving such local stakeholders.

Aligning policies and investments is typically a matter of devising **multi-level governance** structures that allow for alignment between policy domains and jurisdictions. A common threat for holistic planning is the need for authorities to take responsibility over their own domain (e.g. sustainable mobility, access to affordable mobility, or spurring economic growth), which does not always fully match with the objectives of integrated plans as prioritised in the transition headlines of Greece. Similarly, there can be tensions between the activities of national and regional policy makers. At the moment, it is not clear to what extent regions and municipalities have a formal role in realising NECP targets. Not only are authorities at the sub-national level in the position to undertake quick actions, it might also be easier for them to bridge the walls between policy domains.[48] For instance, city councils can play a leading role in orchestrating the electrification of mobility, motivated by improvements in air quality, noise levels and human health, and opportunities electrification offers for urban regeneration. Contrary to ministries carrying responsibility for only one or some of these

[48] Wanzenböck & Frenken (2020). The subsidiarity principle in innovation policy for societal challenges. *Global Transitions*, 2: 51-59.

issues, city councils are able to search and reward solutions that create value by addressing such issues all at once. While not all city councils in Greece may have the necessary administrative resources and capabilities, city councils in most large cities can certainly play an important role.

Interregional learning

The above also points at another advantage of aligning national plans and activities with sub-national innovation dynamics. A current weakness is that successful innovative RES projects are often scaled up only to a very limited extent. After resources have been invested in finding technologies and application possibilities that fit the Greek context, it still remains challenging to exploit the results at a larger scale. It would enhance both the efficiency and effectiveness of experimentation if the lessons learned in actual projects would spread to other places as well. These learning opportunities concern both the findings on what technologies and business models might work (e.g. when linking RES to batteries and transport), as well as the processes related to experimentation with renewal (e.g. how to manage transdisciplinary co-creation activities). The diffusion of lessons may be self-organised and occur via intra-regional interactions, or follow a centralised approach in which experiences and results are integrated into regularly updated holistic plans on how to achieve the headline targets. Particularly promising in this respect is the use of **demonstrator experiments**. These are projects that already from the outset have an ambition to obtain lessons that might be valuable for a selection of other contexts (either regions or application areas). Especially on the islands and in some ports, there are successful experiences with such demonstrator experiments. For instance, the DAFNI Network of Sustainable Greek Islands has been involved in pilot projects on topics like innovative energy approaches and Smart Islands, which has yielded findings also exportable to other non-interconnected islands.[49]

However, these promising experiments, despite demonstrating success, currently have no obvious path for national rollout. This is an important problem that should be addressed. Possible ways to spur the rapid uptake of promising experiment results include the launch of funding calls dedicated to *upscaling* and *out-scaling,* rather than just the initial invention and innovation (see also Box 2 for some practical ways forward).[50] Upscaling refers to the process of diffusing innovations in an innovation system, which often requires entrepreneurship activities targeted at overcoming formal and informal institutional barriers (regulation, expectations, and etcetera). Out-scaling, on the other hand, concerns the 'horizontal' process of knowledge sharing between organisations. If organisations from different industries or societal sectors have difficulties in understanding each other – which is typical for transdisciplinary transition experiments -, out-scaling processes benefit from the involvement of intermediary brokers. More generally, for both diffusion modes it is acknowledged that innovative organisations receiving subsidies for setting up experiments are not always in the best position to also take up the role of challenging sources of resistance and spreading knowledge. This implies that diffusion-oriented funding could explicitly aim to involve other stakeholders – like branch organisations, citizen organisations, NGOs - in paving the way for nation-wide diffusion of results. The associated upscaling funding scheme can also contain different tracks for different diffusion phases, reflecting the steps from prototyping to (larger scale) demonstration, replication, accumulation (linking one experiment to other experiments), and finally transformation (the adaptation of institutions, driven by the experiment).[51] Overall, having a funding mechanism for the diffusion of experiment results is particularly important to the credibility of the experimentation-learning-deployment model that is necessary for successful industrial transition.

[49] https://dafninetwork.gr/en/

[50] See: Hermans, F., Stuiver, M., Beers, P. J., & Kok, K. (2013). The distribution of roles and functions for upscaling and outscaling innovations in agricultural innovation systems. *Agricultural Systems*, *115*, 117-128.

[51] Naber, R., Raven, R., Kouw, M., & Dassen, T. (2017). Scaling up sustainable energy innovations. *Energy Policy, 110*, 342-354.

Box 2: How to practically support learning from policy experiments

Possible practical actions to replicate and rollout nationally the successful elements of ongoing experiments include:

Studies: Targeted studies can generate policy intelligence on what it would take to facilitate market creation. Detailed studies can carefully investigate what it would take for private investors to be attracted to their deployment, with a focus on legal and regulatory clarity.

Funding calls: Launch specific funding calls dedicated to following up the DAFNI and Smart Islands experiments, with a view to replicating their successes and scaling up their deployment nationwide. This is particularly important to the credibility of the experimentation-learning-deployment model that is necessary for successful industrial transition.

Embed lessons from experiments into the technical specifications of large infrastructure projects: Engage in publicly funded large infrastructure projects that create multiple-value (economic, social, environmental, human health), leveraging public-private partnerships and strategic public procurement.

Enable connections between initiatives, organisations and levels of governance to learn from experiments: Create a space for learning, exchange of experiences, and stakeholder cooperation that can lead to a sustained pipeline of projects. An on-line knowledge platform, coupled with suitably adapted Entrepreneurial Discovery Process workshops can play some of this role.

Industry involvement

To make planning even more holistic, the future system might look for means to enhance industry involvement. For an industrial transition to succeed, it is crucial to understand the opportunities private businesses would like to pursue and the barriers they encounter. While the government can be bold and set priorities - or perhaps even a **roadmap** for getting there -, success would depend very much on the appetite of businesses to engage and invest. At the level of Greek ministries there are good experiences with '**fora**' via which stakeholders, including industrial players, are consulted. Examples are the Forum for Industry and the Forum for Agriculture. Most of these experiences concern interactions in the initial and final stage of a policy cycle, often in relation to a relatively straightforward policy instrument targeting a single problem (instead of policy mixes addressing complex socio-economic transformations). Firms can provide their views in the planning phase of an instrument, or as part of a monitoring committee overseeing the implementation of that instrument. In case of an industrial transition, however, it is more likely that more continuous engagement would be necessary. Unfortunately, from the side of industry itself there seem to be few structures for exploring positive-sum collaboration for innovation (and transition) paths. A lack of intra- and inter-industrial coordination could prevent the identification of promising investment perspectives. For instance, as long as it is not known which industries are looking to apply new batteries and RES-solutions, it will be hard for firms to assess the benefits of moving into this direction[52]. Moreover, existing associations or federations of industrial players typically have little institutional capacity to effectively inform policy makers. Even if such structures would be able to discover promising and shared diversification pathways, they are limited in their ability to influence policies. Thus, when considering the creation of a working group for e.g. a domain like 'clean shipping', it is highly recommended to not only involve different ministries, regional authorities and ports; also having ship owners and power technology providers on board improves the chances of finding commonalities in the interests of stakeholders that depend on each other when making clean shipping a success.

[52] This is not a hypothetical example: Export-oriented businesses interviewed during the course of the review linked their lack of interest in the Greek market with the inability to estimate the size of the potential market. Policy intelligence that quantifies and localises the needs for energy storage may encourage investment.

3.2 Resource mobilisation

3.2.1 Financial resources

As already established in chapter 2, the need to repay its excessively high debt leaves the Greek government with little opportunities to mobilise the financial resources needed to catalyse a transition. Private investments are constrained as well, as there are many barriers in terms of cost of capital and regulation. Greece historically also has a relatively poor track record of attracting FDI, although the government's commitment to improve this record is commendable and seems to yield some positive momentum[53] on which to build on. While bank loans could sometimes be a viable alternative for business financing as well, such loans are typically not available for new solutions still in a development stage. In sum, there is a pressing need to effectively leverage precisely those funding opportunities that in the Greek context are most suitable for nurturing transition paths.

EU funding

One evident potential source of financial resources are the various EU funding schemes.

- The European Green Deal Investment Plan (EGDIP), is expected to mobilise at least EUR 1 trillion in sustainable investments across the EU by 2030 by leveraging more than EUR 500 billion from the EU Budget and EUR 25 billion from the EU Emissions Trading System (see Box 3). EU funding can also provide long-term financing and orientation, as part of a dedicated **future RIS3 priority.**
- New EU financial instruments (e.g. from EIB, EU schemes for private investments). Up to EUR 800 billion could be further mobilised by the Recovery and Resilience Facility, of which about 30% will be dedicated to the sustainability transition.

Box 3: How will the EU budget mobilise at least EUR 1 trillion over the next decade?

Mobilising at least EUR 1 trillion over the next decade requires a combination of funds provided by the EU budget as proposed by the Commission and further public and private investments triggered by it.

Climate and environmental spending under the EU budget will provide EUR 503 billion from 2021 to 2030, in line with the 25% climate mainstreaming target proposed for the 2021-2027 multiannual financial framework (MFF) and including spending on the environment across all programmes. This will trigger additional national co-financing of EUR 114 billion over this timeframe on climate and environment.

The InvestEU Fund will leverage around EUR 279 billion of private and public climate and environmentally related investments over the period 2021-2030 by providing an EU budget guarantee to reduce the risk in financing and investment operations.

To leave no one behind, the Just Transition Mechanism will include financing from the EU budget, co-financing from the Member States as well as contributions from InvestEU and the EIB to reach EUR 100 billion of investments to be mobilised over 2021-27, which, extrapolated over 10 years, will reach EUR 143 billion to ensure a just transition.

The Innovation and Modernisation funds, which are not part of the EU budget but are financed through a part of the revenues from the auctioning of carbon allowances under the Emissions Trading Scheme, will provide at least some EUR 25 billion for EU transition to climate neutrality.

For more details see: Commission Communication on the Sustainable Europe Investment Plan.

[53] According to the most recent data of Bank of Greece, the (net) inflows of Foreign Direct Investment in Greece for 2019 amounted to €4,137 million (the highest amount since 2006) compared to 3,364 million in 2018, presenting an increase of 23.0%. 2019 is the fourth consecutive year of increase of net foreign direct investment in Greece, following an annual increase of 9.0% from 2017 to 2018, 23.5% from 2016 to 2017 and 118.5% from 2015 to 2016 (source: https://www.enterprisegreece.gov.gr/en/greece-today/why-greece/foreign-direct-investment).

Procuring development and innovations

In addition to attracting additional financial resources, the Greek government can also make clever use of its own budget to drive innovation. At the ministerial level there is an increasing interest for **pre-commercial procurement (PCP)** and **public procurement of innovation (PPI)**. Pre-commercial procurement "challenges industry from the demand side to develop innovative solutions for public sector needs and it provides a first customer reference that enables companies to create competitive advantage on the market"[54]. Policy makers can engage in PCP by asking the market to propose potential solutions for an expressed need. Over the course of several phases the procuring authority and an increasingly small number of competing firms would move from solution design to the validation of an actual product or service. PPI, in contrast, focuses on the procurement of innovations that already have been developed by the market. In many cases it would still be important for those market players to get a first customer and gain experience with offering the innovation, but sometimes public procurement is still based on criteria not applicable to or even disadvantaging an innovation. Apart from learning how to formulate demands that invite for innovation, engaging in PPI often entails a revision of the procurement criteria.

While the potential of both PCP and PPI is acknowledged, as evidenced by the activities of the Ministry of Development and Investments' Directorate for Public Procurement, it is still hardly used at this point in time. One explanation is that, despite being based on existing procurement budgets, the use of PCP and PPI does require some additional funding. The extra resources are needed for setting up the demand formulation and search for solutions, as well as the financing of alternative solutions until one option has been chosen. What is often neglected is that PCP and PPI also demand different capabilities from the government officials charged with the various aspects of the procurement process. The Directorate for Public Procurement is currently taking this up via e.g. the development of **training courses** for public servants from different government layers. Finally, it is essential that the procurement staff does not just know how to incorporate innovation and sustainability into their procurement processes, but that they also have a mandate for doing so. This requires the presence of high-level strategies that demand innovation and sustainability in the first place. Currently, policy makers (in public organizations at either the national or regional level) seem to be insufficiently aware of what PCP and PPI could mean to them. Whenever Greek policy makers start to embrace ambitious headline targets, it would be helpful if they had a better understanding of how they can use their own resources for catalysing change rather than leaving innovation funding entirely to authorities responsible for economic development. While some **events** have been planned to bring PCP and PPI under the attention of policy officials in different ministries, this can be complemented with activities targeted at policy makers at the highest strategic levels. Helpful in this respect would also be the availability of compelling **evidence** strengthening the case for PCP/PPI. Policy makers might be more convinced about the potential of procurement when confronted with either statistical evidence from other countries, or with experiences from early PCP/PPI adopters within Greece– e.g. within the Ministry of Defence, which has embarked on PCP/PPI in the context of some of its demands.[55]

Enforcement of environmental regulations

A long-standing issue holding back business investment in recycling, and other industrial paths towards a sustainable economy, is the inability of the Greek state to enforce environmental legislation and regulation. Lack of enforcement encourages free riding and prevents what is internationally a capital- and knowledge-intensive industry from thriving. The issue was highlighted as far back as the OECD Environmental Performance Review of Greece in 2000 and again in 2009[56], but as our discussions with stakeholders make clear, it is still far from being addressed. In the absence of

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54 https://ec.europa.eu/digital-single-market/en/pre-commercial-procurement

55 For the outlines of a framework for procurement, see the 2017 Defence Industrial Strategy (in Greek): http://www.gdaee.mil.gr/images/PDF/%CE%95%CE%91%CE%92%CE%A3_290317.pdf

56 OECD (2000), *Environmental Performance Review: Greece*, OECD, Paris; OECD (2009), *Environmental Performance Review: Greece*, OECD, Paris. One of the OECD's (2009) key recommendations were: "[…implement plans to strengthen the financial and human resources devoted to the new environmental inspectorate; continue to promote compliance with and enforcement of environmental and land use regulations."

enforcement, the rudimentary Greek recycling sector does not reward long-term investments and remains centred on the informal economy. Finding **effective ways to observe the enforcement of active legislation** may perhaps be the most important short-term contribution of policy to altering the cost and benefit calculations of the affected industry.

(Financial) valuation of transition impact

Another way of enhancing the financial possibilities for industrial transition in Greece, is to ensure that the merits of innovative sustainable solutions are recognised and rewarded. In the desired state of the system, transactions like investments and purchasing orders by either public or private parties properly value what contributions a certain deal can make to the transition. This holds for funding and procurement, but also for e.g. ports running a bidding process for parties aiming to exploit a part of the harbour territory. In all cases, it would be helpful if there were for instance **rating tools** that help to easily value the sustainability-enhancing potential of innovative proposals. At the moment, authorities executing a bidding process perceive it to be difficult to favour desirable projects, simply because there are no clear metrics that properly capture the advantages a project can provide for the transition. A strong focus on costs and/or purely financial returns obscures the merits of activities that may pave the way for follow-up innovation and diffusion. For instance, an experiment with smart grids and EV-infrastructure can yield knowledge spill overs as well as adoption spill overs (e.g. more legitimacy for such solutions, more experience), but usually will not leave behind the kind of evidence that allow objective evaluation of costs, benefits and returns on investment that are of central interest to investors or procurers. Adopting and adapting rating tools used (internationally) for e.g., green finance[57] would be one possibility to warrant that the most promising innovation projects are not at a disadvantageous position when searching financial resources.

Transparency in support measures

Finally, there is the issue of a fragmented funding landscape. Across the layers of European, national and subnational policy schemes there is a variety of public funding possibilities firms might consider. The variety is large also because the envisaged industrial transition, based on RES- and energy storage innovations in transport and other domains, cuts across many policy domains. Developers of integrated solutions might face a mix of subsidies, PCP/PPI and regular procurement possibilities across domains like economic development, business support, mobility, energy, etc. There appears to be a demand for a **digital one-stop-shop** providing firms an overview of at least the public support measures they might benefit from, beyond the calls through espa.gr.

3.2.2 Human resources

Apart from sufficient financial resources, an industrial transition involving a combination of sustainable economic activities also requires availability of the right human resources. The Executive Agency for ESIF Funds at the Ministry of Employment and Social Affairs is aware of the challenges and the opportunities faced by the national labour market due to global trends and is readjusting its strategy aiming, among others, to increase the share of proactive labour policies in the overall policy mix (pre-empting unexpected labour market shocks via e.g. job creation or job counselling), to emphasise the provision of skills to technology-driven sectors, and introduce systematic impact assessment. The high level of university graduates in disciplines related to this transition is not matched by the employment opportunities currently available in Greece and therefore, a high number of well-trained young graduates has moved abroad. Increased interregional mobility of young graduates is also observed between remote and less developed regions and major urban areas. Raising the demand for skilled employment requires favouring industrial development paths that thrive on knowledge. Besides measures encouraging long-term productivity-enhancing investments, a way to reverse the interregional and international brain drain is to favour industrial development paths that respond to local challenges, many of which already receive policy attention and resources

[57] See, for example, EU activities related to defining sustainable activities: https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

(though without necessarily incorporating an employment creation objective), and many of which are increasingly environmental, and doing so in close collaboration with regional stakeholders.

Vocational training

Conversations with relevant stakeholders suggest there is a chronic misalignment of education and skills provision with market needs. Additional challenges include low levels of in-firm training and a system for vocational training that is incomplete (covering only very small parts of school-to-work transition, lacking in lifelong learning), underappreciated (mostly absorbing academic underachievers and with concomitantly low market recognition) and underperforming (as often mentioned in literature characterised by obsolete professional frameworks and outdated curricula)[58]. A positive development worth mentioning by the Ministry of Employment is the launch of an **online platform** that provides insight into the skill types that are currently demanded by industry[59]. These skill types are linked to the scope of vocational trainings, in order to identify any mismatches between what is needed and what is offered. By **certifying and accrediting the offer of vocational training**, more transparency would emerge regarding Greece's capacity to update the capacities of its working population. This effort obviously depends on the ability of businesses to articulate what they are looking for. A major threat is that a partial and mismatched vocational skills provision system may hold back local business development for lack of relevant skills, while leaving large swathes of the workforce without the necessary skills to be productively engaged in new growth sectors. Another threat is that people receive a training with little use for the activities that are present or emerging in the Greek economy, so skills development related to the transition should be progressive and linked to the development of productive capacities.

One relevant effort to counter such events is the establishing of additional **regional training centres**, or **'field labs'**, in which firms and universities jointly give shape to the curricula. Inspiration could be drawn from the already existing Lifelong Learning Centres (LLC) providing vocational training programmes, as found in areas like Attica and Crete.[60] Centres like these are often forward-looking, especially when they have a theme which might be of increasing relevance to the local industry. Examples of such themes could be recycling, energy performance assessment, 3D-printing and electric vehicles. By consulting industry about their future rather than current needs, and embedding the centres in the local context, the goal is to train employees that might not just fulfil the existing labour demands of firms but also help them to develop even further. This approach, despite still in an early stage, provides inspiration for how other regions can train and retain their working force.

The regional training centres that have been established so far were largely the initiatives of local municipalities. When seeking to roll this out nationwide, there are opportunities to link up with, and learn lessons from, the European **'Centres of Vocational Excellence' (CoVEs)**.[61] At the moment, there are five pilots of centres that have received around €1m EU funding each. The centres operate as transnational cooperation platforms for the (co-)creation of 'skills ecosystems'. By engaging a wide variety of local stakeholders in teaching and learning activities (both vocational and at schools/universities), the centres aim to prepare labour markets for a digital and sustainable future. A key objective is upgrading both the *quality* of dispensed training and its *perception* among beneficiaries and recruiters. These objectives are an especially good match for the needs of Greece, as a counter to the prevailing skills chasm between workers who undergo tertiary education and the rest. After the pilot phase, a substantially larger budget will be available for a larger set of CoVES in the coming years. This presents a timely opportunity for the Greek industrial transition, as it can boost initiatives to unite training, vocational education and business-led research around themes like batteries, smart grids, clean shipping, etcetera.

58 See Lalioti, V. (2020), Interconnection of Education and Labour Market (in Greek).

59 The Greek Labour Market Diagnosis System (https://lmd.eiead.gr/) is run by the National Institute of Employment and Human Resources since 2016, being funded by the OP Development of Human Resources. Education and Lifelong Learning.

60 CEDEFOP (2014). Vocational education and training in Greece. www.cedefop.europa.eu/files/4130_en.pdf

61 https://eacea.ec.europa.eu/erasmus-plus/actions/centres-of-vocational-excellence_en

3.3 Production

3.3.1 Manufacturing and Services

Moving to a sustainable yet competitive economy involves the *development* and *deployment* of a range of new products and services. While Greece does not have at the moment sufficient industrial capacity to engage in large-scale experimentation and production, global developments and the foreseeable consumer shift towards renewables and sustainable mobility present a unique opportunity to change this. Policy can make important contributions to advancing the transition by putting in place the conditions for a dynamic business sector with advanced production capabilities to emerge. Creating *a system* that nurtures the production of products and services thriving on knowledge requires on the one hand the removal of pressing barriers, and on the other hand support and path-opening interventions for pursuing promising opportunities.

The (renewed) importance of industrialisation

There is a pressing need for Greece to diversify into sectors that are internationally tradable, environmentally sustainable and knowledge-intensive. Greece does not have a developed tradables sector and much of its manufacturing is poorly connected to global value chains. Moreover, unbalanced structural change over the past decades, have enlarged economic activities related to tourism and non-internationally-tradable services. Dependence on any one sector can be a source of vulnerability to external shocks, a fact vividly demonstrated by the proportionately higher projected economic impact[62] of the pandemic on Greece compared to its EU peers. Internationally, an excessive reliance on tourism in particular has been shown[63] to resemble some of the undesirable features of reliance in extractive industries (such as petroleum): these include competition for entrepreneurship and investment opportunities, rising labour costs pricing out other sectors[64], environmental degradation (and intergenerational shift of the costs of production), all collectively contributing to de-industrialisation. Foreign Direct Investment (FDI) can be a route to industrialisation and insertion into global value chains. However, in Greece FDI stood at just under 15% of GDP in 2016, an especially low share in comparison with most of its EU peers[65]. According to the most recent OECD Economic Survey of Greece, Greece has relatively few obstacles to foreign investment. Investment paths need to be encouraged, with concerted attempts to strengthen innovation, skills, the investment framework and the regulatory environment. Efforts can be more effective when they are tailored to the needs of a specific production and consumption system. This requires context-specific intelligence about needs, responsiveness to stakeholder concerns, including providing legal and regulatory certainty, and acting on time when rare windows of opportunity emerge.

Productive transformation in renewables and transport

There are mounting indications that precisely such a rare window is currently open in renewable energy and transport in what may be a once in a century opportunity[66]. According to the International Energy Agency[67], global investment in *renewable energy is overtaking investment in fossil fuels*; the – strongly complementary – electrification of transport despite its low level is already on an

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62 European Commission (2020), "European Economic Forecast. Spring 2020", Institutional Paper 125, May, https://ec.europa.eu/info/sites/info/files/economy-finance/ip125_en.pdf

63 See for instance, a study of Spain by Inchausti-Sintes, F. (2015), "Tourism: Economic growth, employment and Dutch Disease", *Annals of Tourism Research*, Vol. 54, pp. 172-189

64 In the years leading to the financial crisis, Greece was one of the countries with the highest-growing unit labour costs in non-tradables sectors. See p.141-142 in OECD (2018), *Productivity and Jobs in a Globalised World: (How) Can All Regions Benefit?,* OECD Publishing, Paris. http://dx.doi.org/10.1787/9789264293137-en

65 OECD (2018), *OECD Economic Surveys: Greece 2018*, OECD Publishing, Paris. http://dx.doi.org/10.1787/eco_surveys-grc-2018-en

66 Perez, C. (2013), "Unleashing a golden age after the financial collapse: Drawing lessons from history", *Environmental Innovations and Social Transformations*, Vol. 6, pp. 9-23.

67 IEA Energy Outlook 2019

exponential growth trajectory[68]; moreover energy production, distribution and consumption is becoming increasingly "smarter", as a result of *pervasive digitisation* that permits new business models and nurtures knowledge-intensive employment. Importantly, there are good reasons to believe that this is an employment-intensive transition: a recent forecast[69] estimates that direct jobs associated with the electricity sector alone are going to increase from about 21 million in 2015 to nearly 35 million in 2050. According to the same study, the main job-creating technologies are likely to be solar photovoltaic, batteries and wind power, whereas an important part of new jobs will be in activities related to installation, maintenance, repair and recycling.

Greece already has – still small - niches of strong productive capabilities within the energy and transport system, and an internationally outstanding science base, embedded within their overall weak industrial sectors. In addition, Greece stands to benefit from unprecedented amounts of EU funding linked to the European Green Deal and the EU Recovery Fund, much of which will be directly linked to the green and digital transitions. Greece's 10.7 million inhabitants, over eight hundred thousand businesses, and 5 million vehicles require energy, a rapidly increasing proportion, and eventually the majority of which, is going to be electricity, produced sustainably, locally, and stored for some period in advance of its use. Even if the current production system in Greece is unable to meet these needs, supply does eventually follow demand. In the absence of advance planning however, there is no guarantee that the transition will lead to a diversified, knowledge- and tradable-intensive Greek economy, or that the benefits from the transition will be widely felt. Advance preparation, and wide stakeholder coordination, including with local communities who stand to gain or lose the most, is necessary. A coherent strategic response to the current challenge should contain at least three elements:

- Targeted interventions and institutional reforms meant *to forge the necessary links* to turn the disparate strengths within the energy and transport sectors into a vibrant export-driven industrial system, thriving on innovation. These notably include the links between the sources of finance (banks, equity investors, Greece's own EquiFund[70], foreign investors, EU funding and the EIB), businesses (manufacturing, distribution, installation, maintenance, recycling), domestic consumers and foreign markets (households for energy, and individuals for transport solutions, export promotion especially in markets where Greek firms already have a foothold) and education, training and research providers (including upgraded vocational training centres, corporate R&D labs, universities and public research institutes).

- The *boldness* and *clarity of purpose* that brought forward the closure of lignite mining operations and the newly signed Greek Green Pact for Electric Mobility[71], can also help steer policy more broadly and prioritise public investments that advance the transition in both energy and transport *in parallel,* particularly those that *leverage business investment* and *consumer demand*. The obvious next step in this respect would be the launch of *a national mission on energy and mobility transition*, in which local industrial development and the creation of high-quality employment are chief objectives. A national mission can act as a rallying point and facilitate the extensive whole-of-government mobilisation and stakeholder cooperation required for acting quickly to seize the opportunities.

- *The intensification and upgrading of public contributions* to instruments that raise the rate of return to investment, and have been shown[72] to attract FDI, in renewable energy [notably feed-in tariffs, fiscal measures, Renewable Portfolio Standards (RPS), carbon taxes]. Along similar lines, policy can link transport investments to predictably evolving consumer

[68] In 2018, the global electric car fleet exceeded 5.1 million, increasing by 2 million compared to the previous year and almost doubling the number of new electric car registrations. See https://www.iea.org/reports/global-ev-outlook-2019

[69] Ram, M., Aghahosseini, A. and Breyer, C. (2020), "Job creation during the global energy transition towards 100% renewable power system by 2050", *Technological Forecasting and Social Change*, Vol. 151, doi: 10.1016/j.techfore.2019.06.008

[70] https://equifund.gr/

[71] https://energypress.gr/news/20-foreis-ypegrapsan-tin-prasini-symfonia-gia-tin-proothisi-tis-ilektrokinisis-olokliro-keimeno

[72] Wall, R., Grafakos, S., Gianoli, A., Stavropoulos, S. (2019), "Which policy instruments attract foreign direct investments in renewable energy?", *Climate Policy*, Vol. 19(1), pp. 59-72, doi: 10.1080/14693062.2018.1467826

preferences and leverage the buying power of consumers, and put forward spatially-targeted investment incentives in territories that are expected to be particularly affected by the transition, such as Western Macedonia and Megalopolis.

Stability and demand articulation

The probability that firms will invest in (new) products and services is, apart from access to capital, dependent on how much market perspective there is for certain investments. Generally, the situation already improves when regulatory instability is kept to a minimum, as this is known to reduce the appetite for the type of longer-term investments characteristic for transitions involving complementary system changes (e.g. innovation, regulation, and infrastructure). At the moment, the degree of instability is believed to be concerning, which also links back to the lack of coordination between the various policy domains that coincide in the topic of RES- and battery-based transport – see section 10. For the desired state of the system it is important to strike a balance between having an *adaptive* strategy backing the most promising development paths, versus *avoiding drastic strategy and policy changes* that might scare away stakeholders that did have the intention of being part of the industrial transition.

Additionally, market perspectives look brighter when there is more clarity regarding the potential usage of new products and services. Especially in the face of uncertainty, which is typical for transitions, many demands can largely remain implicit and latent. To gear up the production of promising solutions it helps if there are policies for articulating and aggregating such demand. This holds for instance for the privately owned harbours that currently refrain from investments in electrification and waste services (e.g. for the disposal of the catalyser urea) for visiting transport ships. It is acknowledged that joining the limited set of harbours that meet high environmental standards might yield a competitive advantage for the Greek economy, but currently it is not clear how that would pay off for the individual harbours that are required to make the investments. As long as transport companies or other stakeholders do not ask explicitly for sustainable port services, a deadlock situation remains - thereby damaging opportunities for Greece to move quickly into activities in which it could excel. A suggested solution for this particular example is to consider the provision of harbour fee discounts for clean shipping. Greek firms obtaining an advantage of increased shipping volumes would probably need to take part in financing these discounts, but on the longer run it might prove an effective acceleration of the step towards sustainable and cost saving circular ports. Realising such strategies is again a matter of coordination, in this case between the variety of parties that would need to build business cases around both their individual role as well as the roles of other parties in (a particular element of) the envisaged industrial transition. The existing business networks around batteries, RES and transport generally seem too weak and narrowly focused to identify development routes uniting all their interests.

Enforcing environmental regulations and introducing additional market-creating measures

Yet another factor contributing to the willingness of parties to invest in the industrial transition is the extent it pays off to be sustainable. An often-heard complaint is that at the moment there are too many opportunities for firms to get away with practices not meeting environmental regulation. This means that the industrial transition does not only require regulatory changes more suited to the desired production-consumption system, but also sufficient enforcement of those regulations. Firms now perceive that competitors are ignoring pollution norms, thereby reducing the general appetite for producing green technologies. Intensifying enforcement might be a relatively low-cost policy option for improving the playing field for RES use and proper waste management.

Enforcing regulations can be followed up with additional market-creating measures. One such measure would be the provision of legislation about the deployment and use of new technologies – this should be path opening but not prescriptive about the specific solutions, promoting multiple alternative technologies (e.g. in energy storage not just batteries, but also hydrogen and pumped hydro) in parallel. These require extensive stakeholder involvement and should be designed in ways that safeguard the interests of smaller companies and allow them to explore new business models. Agility will be very important. If linked to a mission, associated legislative initiatives must precede

support for investment (e.g. subsidies), and will have to happen quickly. Likewise, land use regulation can create markets e.g. for energy storage, or for recycling and industrial waste management by earmarking publicly owned land for industrial use in general or for specific purposes, linked to increased needs for energy storage (e.g. small scale pumped hydro, which could be a solution to grid balancing for RES throughout the country and can be constructed by local firms and by readily available skills and technology).

Infrastructures and data

Another market-creation intervention would be the public provision of suitable infrastructures or the provision of incentives for their development by the private sector. In the context of Greece's headline targets, this would concern for instance a major update of the electricity grid, charging infrastructures for electric vehicles, or distribution and refuelling facilities for hydrogen powered vehicles (e.g. long haul lorries or hydrogen boats). When pervasive and digitalised metering is introduced throughout the system, this would produce the type of data on energy production and consumption that is needed for optimising the distribution and pricing of energy. Also, the availability of such data would allow for the development of new smart grid services (as long as it is complies with GDPR legislation) and business models. It is obviously a substantial task to update the entire electricity grid at once. Some infrastructure and services may be introduced by large utilities and be financed by consumers willing to pay for them. Others, however, particularly those that could offer opportunities for smaller innovative companies, may require experimentation which has to happen in a protected environment. To discover which business cases work under what circumstances, it will be important to introduce micro-grid enabling legislation. Creating **regulatory sandboxes** (see Box 4) in some specific places allows not only for the demonstration of new technologies, but also for getting experiences with the business model and users' side of having access to grids that are combined with new services. Lessons learned in such settings can inform decision making on how to organize and finance the improvement of other parts of the electricity grid in a later stage of the transition. Regulatory sandboxes require a regulatory authority (e.g. an independent energy regulator, such as RAE in Greece) to approve exemptions from prevalent rules for well-defined purposes, providing safeguards and oversight to avoid excesses. These all place an additional burden on the public administrations that staff regulatory authorities, so a first step towards the introduction of sandboxes would be to upgrade the capacities of relevant regulators.

Box 4: Regulatory Sandboxes

Regulatory sandboxes are real-world testing environments that facilitate experimentation by lifting (often temporarily) particular regulatory barriers.[73] The main idea is that it is hard to adjust laws when it is not clear yet how an innovative idea or solution will work out. To be at least able to figure out under what conditions an innovation might work - and what social, economic, environmental and institutional effects this may have - , it can be helpful to remove legal obstacles in a certain place and timeframe. Lessons about the experimentation this allows for may then provide the basis for informed adjustments of outdated laws and rules. As Van der Waal et al. (2020) put it: "A main characteristic of these sandboxes is that they allow for a two-way regulatory dialogue between an experimenter and a regulator to innovate regulation and enable new socio-technical arrangements"[74]. A typical feature of sandbox experiments is that they usually do not concern the demonstration of one innovation in particular, but that they invite various stakeholders to participate in the development and testing of multiple innovations.

[73] Lowitzsch, J., Hoicka, C. E., & Van Tulder, F. J. (2020). Renewable energy communities under the 2019 European Clean Energy Package–Governance model for the energy clusters of the future?. *Renewable and Sustainable Energy Reviews, 122*, 109489.

[74] Van der Waal, E. C., Das, A. M., & van der Schoor, T. (2020). Participatory experimentation with energy law: digging in a 'regulatory sandbox' for local energy initiatives in the Netherlands. *Energies, 13*(2), 458.

While the rising interest for regulatory sandboxes as an innovation-supporting policy instrument cuts across many policy domains (including finance and digitisation), much of the attention stems from debates on sustainability transitions. The aforementioned article by Van der Waal et al. (2020) discusses how countries like the Netherlands and the UK have started to create possibilities for policy makers to set up regulatory sandboxes regarding energy initiatives. In a recent article on renewable energy communities and renewable energy clusters, Lowitzsch et al. (2020) explain how regulatory sandboxes might set conditions that enable the testing of various incentives and "the required business models to identify best practise when overcoming obstacles stemming from a lack of compatibility with the existing legal and regulatory frameworks." (p. 12)[73].

3.3.2 Research and Development

Knowledge production

For some parts of the envisaged industrial transition, it is crucial to have state-of-the-art knowledge production. A reason to take batteries as a starting point for the transition is the relatively strong position in this domain. This position may be leveraged by using it as a part of transition paths combining a variety of solutions. For instance, the returns on already developed capabilities can be increased by exploring how lead-acid batteries can be applied in energy grid solutions suitable to their relatively low energy density. While for mobility solutions energy density is a crucial issue, it matters less for e.g. charging infrastructures, household solutions, large-scale stationary energy storage and, somewhat more speculatively, electrified boats.

At the same time, it should also be noted that clinging on to a particular technology (largely driven by one major incumbent player) also poses the risk of being overtaken by countries investing in alternative battery technologies that may be better in terms of performance, price and friendliness to the environment. The risk of losing out does not just concern Asian competition increasingly taking the technological lead, but also to European competitors. It is encouraging that Greece recently successfully participated to the **European Battery Alliance,** one of the so-called projects of common European interest (IPCEI)[75]. Possibilities to participate in more IPCEIs (e.g. on hydrogen and microelectronics) deserve serious consideration.

An opportunity for Greece is to grow a knowledge ecosystem out of the one strong incumbent and the good public research and university training that exists, and do so in segments of the value chain which are still contestable and would anyhow correspond with the national deployment of renewable energy and storage solutions. Having a knowledge ecosystem based on novel interaction patterns could allow Greece to sufficiently renew its knowledge base, and to move into different directions. Ideally, such directions are competitiveness-enhancing yet sufficiently related to the capabilities, sectors, infrastructures and skills already present. Some of these factors could be updated when diversifying, but not all at once. From this perspective, one potential area for Greece to excel in is the **reuse and recycling of lithium-ion batteries** as well as **waste from other new green technologies** like old solar panels and wind turbine blades. At the moment, the global market for recycling these technologies is still small, as the diffusion is taking off only recently. However, it is evident that at some point there will be a large demand for processing technologies that have reached the end of their life cycle. From an industrial transition point of view, it might be clever to anticipate and start investing in relevant capabilities. This does not necessarily only imply knowledge development (as in fact it will be hard for Greece to push the knowledge frontier all by itself), but also the adaptation of regulation and solutions in logistics and infrastructures regarding the very transport and disposal of discarded green technologies.

Another strategic area to consider as a focus point of new knowledge development would be **environmental remediation**. All around the world, there are former mining and harvesting areas that suffered heavily under years of intensive exploitation. Restoring the natural landscape in such areas is increasingly on policy agendas. It could be interesting to explore whether Greece can take the lead in experimenting with new remediation approaches, especially in the context of the Western-Macedonia region now facing the abolishment of its mining activities. The capabilities required for

75 https://ec.europa.eu/commission/presscorner/detail/en/IP_21_226

environmental remediation have a strong overlap with the construction, excavation and metalwork activities that are usually developed in mining territories. If coupled with a strong focus on innovation and skills, the costly and lengthy restoration of the natural landscape could become not just an environmental project, but the basis for a thriving export niche.

Knowledge transfer

Apart from programming knowledge production along some particularly interesting development directions, there is also a need to ensure the resulting knowledge is being absorbed and utilised. This is typically the task of **knowledge transfer offices (KTO's)**. The KTO's are often also involved in supporting academic start-ups. There seems to be much room for improvement of the capacity of scientifically strong research institutes to also spawn successful businesses. The start-up rate is believed to be much lower than it could be, making the case for intensification of **incubation** activities like the provision of housing, networking events, (pre-)seed funding, patenting support, and start up management. Furthermore, some opportunities reside in linking start-ups better to each other and to potential clients. In the particular context of Greece's industrial transition theme this would also concern a special focus on small innovative ICT firms. While this sector is generally lauded for its capacities and performance, it is only marginally connected to the energy sector. Besides a lack of conditions inviting firms across these sectors to team up, this might also be explained by the earlier reported scarcity of energy metering data the ICT firms could work with.

Knowledge exchange

Improving knowledge exchange is another avenue worth exploring. These involves improvements in access to knowledge, and bringing together of organisations and individuals with the required knowledge and capabilities. By improving knowledge exchange throughout **ecosystems** also involving established businesses (large and small) it might be possible to spur discovery processes allowing Greek firms to identify domestic markets in which they can exploit and improve their capabilities. This is particularly interesting when developing solutions that can also be exported later. For instance, it could be considered whether knowledge of electric power trains, in combination with storage technologies (battery charging, hybrid systems in boats, hydrogen infrastructure) can be linked to common technology and service needs across several modes of transport. While the individual aspects of such solutions are present, it takes interaction and alignment to combine capabilities needed for producing the integrated propositions. Attempts to enhance knowledge exchange between relevant players could be centred around emerging national value chains linked to electric vehicle use, maintenance and repair (cars, motorbikes, forklifts), electric boats (retrofitting in small shipyards, hybrid electric/combustion power trains, submarines, recreational shipping). To provide a particular focus, **collaboration agendas** and **networks** uniting such domains can focus on urgent demands, like the installation and maintenance needs of the growing metro infrastructure in Athens and Thessaloniki (covering electric buses, electric trolley maintenance and upgrades, electric trains installation, maintenance and repair). Harnessing the possibilities from the massive consolidation of the transport system around a few key sources of energy and a narrow subset of closely associated (and jointly deployed) technologies is also a way to create knowledge-intensive employment. This, in turn, presents an opportunity to prevent skilled employees leaving the region or even country, thereby hampering the value chains they are or can be part of.

3.4 Consumption/Use

Local RES production

Looking at the final demand for a key element in Greece's headline target, the increase of EV adoption, chapter 2 revealed price to be a crucial issue. The price for at least the fuel part might drop if consumers have more possibilities to create their own energy. Currently it is difficult to be a 'prosumer' (i.e. a consumer who is also a producer, of say renewable energy), due to earlier mentioned constraints in the still to be updated electricity grid. It is likely that the demand for RES-producing

technologies increases when customers can be connected to grids allowing them not just to produce the energy they consume themselves, but also to exchange the surpluses. It is often the mix of consumption and trade that makes the business case for a citizen or firm to invest in e.g. photovoltaics. Options to be a prosumer are now being regulated by the law on local energy communities, allowing small groups of energy producers to trade their energy. In the past the law on local energy communities was abused by firms pretending to be an energy community and getting associated permit priorities, allowing them to bypass lengthy procedures for getting grid access as a prosumer (usurping the place of real prosumers). It is recommended to continue with the intended **reform of the local energy community law** in order to avoid such excesses. At the same time, it is also important to note that the bypassing itself reveals a strong barrier regarding the desire of parties to install RES solutions.

Energy citizenship

Especially on the Greek islands, facing societal challenges of many kinds, the problem is that there currently is hardly any public interest for sustainable energy. Even when municipalities are trying to move forward, they experience that their communities prefer to prioritise other issues (such as e.g. access to water). This asks for intensified efforts to support **energy citizenship**, i.e. making the public aware of the fact that they are active participants in sustainability transitions affecting both energy security as well as socio-economic conditions on the islands. Apart from merely campaigning for more awareness, it might be viable to combine this with financial incentives for adopting RES solutions. One suggestion is to couple RES production with the water network, so that households and firms can trade both: e.g. RES surpluses could be used to power desalination plants, awarding local energy producers water rights. If the energy grid is connected to the mainland, prosumers on the islands could also enhance their RES business case by trading their surplus to places less endowed with natural resources like wind and solar energy. Other possibilities reside in the **integration of other energy solutions** (e.g. directly linking RES production technologies to private EV or electric boats), contributing to the value of household RES investments. It should be noted that some additional problems would then need to be overcome, like the fixed energy price and the fact that businesses require capital to retrofit their boats. Attractive loans for this purpose, e.g. based on state-backed guarantees, might be a suitable support measure for the latter.

'Niches' with special demands

Many of the remarks made above also hold in the mainland context. What is special about the islands is that they represent 'niches'; they provide shielded surroundings with specific infrastructures, demands, cultural characteristics (like local communities) and jurisdictional power that could favour the experimentation with novel solutions. For instance, the demands for EV mobility ranges are typically much more limited than in a mainland context, while setting up a charger with island-wide coverage can be relatively easy. From a transition point of view, it seems fruitful to explore the particular opportunities this presents, in this case in relation to the stalemate between low EV adoption holding back EV infrastructure deployment and vice versa. The fact that islands have their own governments also makes it easier to turn them into **testbeds** where specific regulations apply. The recent joint initiative between the Greek government, the German EV manufacturer Volkswagen and the city council of the Aegean island of Astypalaia[76] can demonstrate some, but not all of the opportunities, and would be worth replicating in a greater diversity of settings. A small window of opportunity also affecting the Greek mainland is the increase of tourists with EVs, adding to the demand for EV charging stations exerted by domestic EV owners.

RES-based public transport

Obviously, the deployment of EV charging stations would not only need to be driven by private firms or households owning electric vehicles. EV varieties like electric motorbikes and electric scooters (known as "micro mobility" solutions) could also be part of last-mile mobility solutions in relation to

[76] https://www.ekathimerini.com/258796/article/ekathimerini/business/volkswagen-adopts-astypalaia

public transport. The expectation is that the use of RES-based EV will increase as transport agencies start to explore new business models based on mobility as a service, e.g. including fleets of electric scooters or even taxis. Looking at the demand coming from public sector consumption, it is worth noting that various Greek municipalities currently look for ways to produce the clean energy needed for green transport. Apart from green public transport, this also covers mobility domains like ambulances or the police and military. Attracting business investment in shared cycling and electric scooter schemes can be a viable path, if these services are introduced in ways that complement existing transport solutions (e.g. by serving localities that are incompletely covered by the existing network), proactive regulation of their use (e.g. electric scooters) address concerns about safety risks.

A lesson identified by successful municipalities is that they can be more agile by using separate legal entities called **'municipality-owned public companies'**[77]. The City of Trikala has a notably successful experience using such an entity to spearhead innovative transport solutions[78]. Operating from such entities rather than from the municipality itself helps to avoid cumbersome regulatory procedures, e.g. when it comes to tendering.

With regards to mass public transport, with the exception of an innovative trial of regenerative braking technologies in the Athens Metro, there are few hopeful development paths, in a system overwhelmed by unsustainable finances and chronic underinvestment. Many transport fleets currently face shortages and lack of maintenance. Shortages and backlogs generally are a bad sign, as they imply that insufficient investments have been made in the existing (transport) system. However, they also mean that there are less sunk costs, and that it might in fact be easier to leapfrog directly to electric alternatives. In practice, this could mean that instead of all cities maintaining both fossil fuel based as well as electric public transport, some of them could make a large scale jump to electric alternatives (reducing average costs thanks to three times lower fuel and maintenance costs) while moving their fossil-fuel based fleet to a city already in urgent need of more vehicles[79].

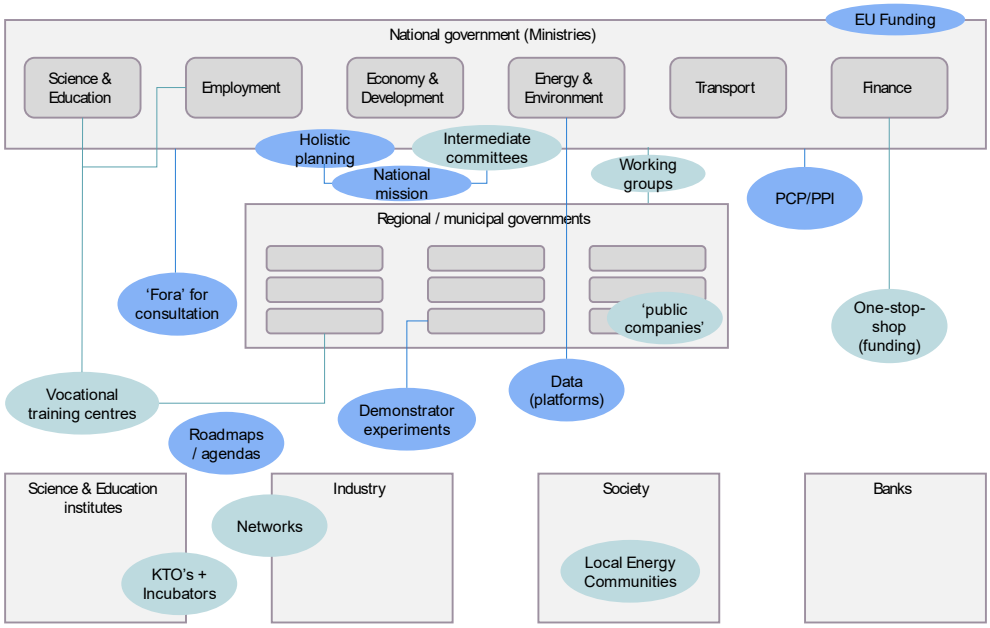
To summarise the analysis provided in this chapter, Figure 25 provides an overview of some of the main directions for improving the system. The improvements should make the system more suitable for pursuing the industrial transition's headline targets. The green circles concern *actors or structures* proposed as useful additions to the existing situation. The blue circles reflect *the policies* that can be developed or intensified to ensure coordination, learning and innovation.

77 As regulated by Laws 3463/2006 and 4548/2018.

78 See http://www.e-trikala.gr/

79 A potentially lower-cost technological solution may be the retrofitting of existing electric trolleybuses in Athens (which in 2017 totalled more than 350 or about 15% of the metropolitan fleet according to: http://www.osy.gr/ethelsite/pages/allBuses.php) with small batteries to allow off-wire capability (up to 15kms) and in-motion charging. See e.g. the EU project "E-bus 2020: In Motion Charging" (https://keep.eu/projects/17632/) and its demonstrator in Arnhem, the Netherlands (https://www.knorr-bremse.com/en/magazine/trolleybus-and-electric-bus-in-one-thanks-to-the-latest-in-motion-charging-drive-system.json)

Figure 25 Overview of actors/structures (in green) and policies (in blue) that can be added or intensified to move towards the desired state and configuration of the system.



4 How to accelerate the transition

4.1 Leverage points (drivers and obstacles)

Based on the analysis provided in chapter 3, there are various particularly interesting policy directions to pursue when realising Greece's industrial transition. The main 'points of leverage' are those intervention possibilities with the biggest potential for meaningful change. They may concern key obstacles to overcome, as well as essential drivers not fully exploited yet. Reviewing the suggestions for where to improve the current system, the following points stand out:

- **Holistic planning under a bold new direction enshrined in a national mission.** An important question for attempts at system-level change, is how to coordinate the actions of different line ministries and their agencies under a coherent industrial development logic. It is not enough to make it part of their task to coordinate with one another: the governance mechanisms that both allow and encourage disparate parts of government with distinct objectives to cooperate must be put in place. Given the high stakes for Greece, the narrowing window of opportunity and the immense coordination task ahead, such a mechanism could be the launch of a *national mission for industrial development and the creation of quality employment*. The chief advantages of a national mission is that it can set a clear direction, raise the degree of ambition and provide long term certainty, while uniting under its umbrella actions across government, and promoting direct accountability about outcomes to the highest political level (e.g. the Prime Minister's Office).[80] Such as a "Greek Green Deal for Jobs" could be modelled after the recently launched Green Pact for Mobility (which currently misses a strong industry development and employment creation dimension), with additional stakeholders and ministries signing up to an ambitious vision of industrial development centred around energy, mobility, ICTs and their applications in services sectors that form the backbone of Greece's economy such as tourism. The national mission must offer a compelling vision, a role for key ministries and a credible future for regions, which stand to lose the most from the transition such as Western Macedonia. A key quality of a mission as a mechanism of holistic planning is that it is an enabler of whole-of-government mobilisation. Similar to a war effort, it leaves no doubt as to what national objective all parts of government need to prioritise: in this case a mission would serve to elevate *industrial development* and the *creation of quality employment* to a major national objective. It can thus secure the primacy of an *industrial development logic* ahead of all other logics of intervention. Across Greece, there are many initiatives that could be integrated into a coherent mission. This includes the policy actions following from the NECP, the Green Mobility Pact as well as initiatives by regional policy makers or industry to update available capabilities and/or to adopt sustainable technologies. The impression arising at the moment is that more impact can be achieved when all these initiatives are better connected to each other. Drawing on concepts like multi-level governance, there seems to be ample room to yield synergies between national and subnational strategic planning in the fields of batteries, RES and mobility. As long as governments work parallel to each other rather than together, it will be hard to achieve the alignment for evoking the right range of complementary investments (in development, adoption, infrastructure, etcetera) and the required scale.

[80] Mazzucato, M., Kattel, R., & Ryan-Collins, J. (2020). Challenge-driven innovation policy: towards a new policy toolkit. *Journal of Industry, Competition and Trade, 20*(2), 421-437.

Box 5: A national mission for Greece

Mission-oriented innovation policies guide the search for innovative solutions to societal challenges by prioritizing an ambitious and specific goal.[81] Especially when the targeted challenge is 'wicked', e.g. due to complexity and contestation regarding the underlying set of problems, it is far from straightforward how the mission can best be managed. Instead of supporting R&D for disentangled parts of the problem, the mission governance would require processes that allow for the identification of solution paths that can be combined, accelerated or aborted when blocking progress in the most promising path.[82] This is likely to be a matter of dialogues between policy makers, industry, science and society, building on the experience gained from the flagship R&D&I actions introduced by GSRT in the programming period 2014-2020. Moreover, since missions concern societal challenges, getting commitment for the development and diffusion of solutions is a process of engaging stakeholders that might provide resources, regulation, access to users, or other types of support.[83]

In the context of Greece's industrial transition, the headline target as presented in this review could be inspirational when formulating a mission statement. For ideas on how then to pursue the goal to which the government would be committing itself, insights can be drawn from other countries that have embarked upon putting missions at the centre of their transformative innovation policies. Examples are the UK's Mission Oriented Innovation and Industrial Strategy, the missions in Germany High-tech Strategy 2025, and the Mission-oriented Top sector policy in the Netherlands. Currently there are not yet many examples of how missions can be organised, especially not from countries containing many lagging regions, but given that they form the basis for the EU's new framework programme for R&D it is likely that more experiences on mission formulation and mission governance will become available soon.

- **Catalysing the transition by leveraging the purchasing power of consumers and public procurement.** Appropriate *sequencing* of actions, e.g. with regards to household investment subsidies stands to leverage consumer demand for industrial development. For example, consider offering support for national industrial expansion (including for joint ventures with globally leading producers and facilitation of FDI) in products and services needed by households to transition, *before* (or at least in parallel to) subsidising household investments in energy efficiency, household RES and storage, and electric mobility solutions. This could encourage the expansion of productive capabilities and lead to the development of a vibrant industrial ecosystem, centred on foreseeable consumer tendencies towards the electrification of mobility, and the democratisation of power generation. Public procurement can operate in similar ways, especially in connection to eliciting and accelerating innovation. As discussed in chapter 3, precommercial procurement of innovation as well as public procurement of innovation allow authorities to mobilise their resources and position to given an impulse to societally desirable innovative developments. By formulating their demands, contributing ideas and redirecting their budgets, national and subnational governments can boost innovations in need of a launching customer. This would not just concern policy makers engaged with topics like energy and mobility policy, but virtually any government procuring energy and transport solutions.

- **Regional thematic 'field labs' for vocational training and research & innovation**. A promising opportunity that has become increasingly apparent concerns possibilities to combine skills development with economic development. At the moment, some experience has been obtained with establishing regional Lifelong Learning Centres involving both (applied) research / education institutes as well as companies (see section 3.2.2). The latter ensures that provided trainings correspond with market needs. Firms are invited to articulate their skill demands and co-define the theme of the training centre. Furthermore, they will also be confronted with the ideas and skills of the institutes providing the trainings, as well as with other firms participating in the centre. The centres can be a leverage point because it can

[81] Mazzucato, M. (2018) Mission-oriented innovation policies: challenges and opportunities. *Industrial and Corporate Change, 27*(5), 803-815.

[82] Wanzenböck, I., Wesseling, J., Frenken, K., Hekkert, M., & Weber, M. (2020). A framework for mission-oriented innovation policy: Alternative pathways through the problem-solution space. *Science and Public Policy*. https://doi.org/10.1093/scipol/scaa027

[83] Hekkert, M. P., Janssen, M. J., Wesseling, J. H., & Negro, S. O. (2020). Mission-oriented innovation systems. *Environmental Innovation and Societal Transitions*, *34*, 76-79.

support the transition in many ways. Apart from providing firms the opportunity to train their own employees or take in suitably skilled new ones, it would also be a place for knowledge exchange and innovation around priority themes – effectively turning the training centres into experimentation hubs or 'field labs'. The potential of such field labs can be enhanced by equipping them with a capability development function as often found in research and innovation competence centres, providing R&D and business services to businesses. Hubs that combine vocational excellence with facilities and training relevant for thematic experimentation activities might serve the innovation ambitions of existing firms but could also yield start-ups. In that light, it could be considered to also attach a start-up incubator and housing functionality to the field lab. The logic behind combining these functionalities would still be to align education and vocational training with the particular innovation ambitions of firms located in a specific region, around a specific set of research and education institutions. Obviously, the possibility to give field labs a thematic orientation (cutting across science, education and industry) presents a possibility to make them part of the holistically planned transition strategy.

- **Ecosystem development**. Another leverage point is to develop stronger ecosystems focused on enhanced interaction between knowledge institutes and firms. There are various (complementary) modes that can be envisaged here:

  - *Ecosystem development around **a strong knowledge institute***. Some of Greece's strong research institutes and universities produce world class knowledge (e.g. CERTH, ICCS/NTUA and FORTH) that can be leveraged into competitive advantage, as long as knowledge transfer mechanisms are sufficiently in place. This includes transfer to existing firms, as well as to start-ups. Especially the latter is regarded as a channel insufficiently utilised so far.

  - *Ecosystem development around a **strong industrial player***. In a domain like battery development, production in Greece is to a large extent dominated by one single party, Sunlight S.A., whose markets are almost entirely abroad. The opportunity for Greece is to use the success of this single company as a springboard for supporting the development of a dense network of SMEs in associated value chains, knowledge development, broad-based skills development and technological experimentation. Although for the firm in question this might bring advantages, its activity in a global and rapidly developing market implies it would also benefit from some smaller local firms in the same industry (or at least value chain). This would allow the key player to focus on its current core activities and on exploring diversification options, while relying on the expertise and inventiveness of (smaller) specialised parties surrounding it. A symbiotic system can be achieved when the business climate and available support mechanisms allow a wider set of enterprises to flourish. Possible actions that can support ecosystem development include enterprise-to-enterprise networks, a strong push on sector-specific vocational skills (possibly with a dedicated Centre for Vocational Excellence), industrial fellowships and incentives for SME upgrading in the relevant value chains.

  - *Ecosystem development around an existing cluster of smaller firms*. Smaller firms can benefit from intensified knowledge exchange with each other, also to articulate their position in the transition. In case the smaller firms do not fully oversee what developments might be relevant for their future, it is important to make some thematic orientation part of their interaction with e.g. the institute(s) that will provide relevant research services and vocational trainings.

- **Smarter and better energy infrastructures.** Since many parts of the energy grid are in need of maintenance and improvement, there is an opportunity to combine this with installing the meters and techniques that will generate market-creating data, and possibly peer-to-peer

energy transactions (if the legal framework is adapted to permit them[84]), as well as detailed and real-time data collection on energy production and energy use. The latter is regarded as an essential prerequisite for the emergence of new RES-based solutions and business models. The availability of future-proof energy infrastructure and associated data can thus at the same time spur RES production as well as (IT-based) innovative economic activities (e.g. on smart grids) that might also be exported to other places.

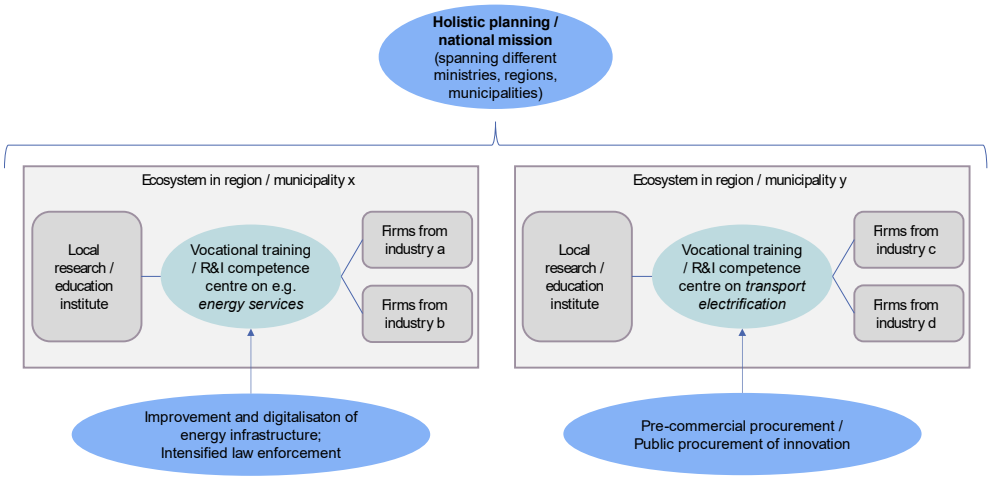
- **Enforcing (and improving) environmental protection and other market-creation actions**. A relatively simple but effective way to drive the transition is to ensure that regulation for protecting the environment is sufficiently enforced. Right now, the impression is that investing in sustainable practices does not always pay off as much as it should, because competitors can sometimes get away with e.g. emissions or waste management practices in violation with regulation. Levelling the playing field through intensified enforcement would at the same time encourage investment and innovation for sustainable solutions, allow associated markets to grow and improve protection of the environment. Also, it is easier to realise than introducing new regulation. Revising regulation and, where necessary, introducing new legislation however should not be disregarded, as it can have powerful market formation effects. Legislation may be necessary to encourage the deployment and use of new technologies, as was recently the case with the legalisation of electric boats. When it comes to domains like the transport of waste (in order to reuse/recycle it), many opportunities are missed due to the lack of regulation regarding the labelling and cross-border shipping of used batteries, wind turbines, and other green technologies. Although changing international laws on waste trade generally is a cumbersome process, it should not be underestimated how many opportunities would emerge for Greece as soon as it gets just a little bit easier to participate in global value chains in the vibrant reuse and recycling sectors. Finally, land use regulation and the public provision of suitable infrastructures can create markets e.g. for energy storage, or for recycling and industrial waste management.

- The abovementioned leverage points stand out because already individually they have the potential to efficiently address multiple obstacles or drivers at once; i.e. by aligning national and regional policies that can reinforce each other, by devoting procurement capacity to acceleration of innovation, by combining vocational training with business networking (the field labs), by unleashing symbiosis helping both large industrial firms and their suppliers, by combining infrastructure development with unlocking the data needed for new energy services, and by improving the effectivity of legislation that can at the same time boost innovativeness and protect the environment.

- Following the principle of holistic planning, most likely even more benefits can be yielded when also properly linking these leverage points to each other (see Figure 26). The field labs (regional Lifelong Learning Centres combining vocational training with experimentation and provision of competences and services for research and innovation) could for instance be a component in a strategy for targeting ecosystem development. When focusing the field labs and knowledge exchange in such ecosystems on topics like innovative energy services, private EV or electrified public transport, it also links to the driver of utilizing smart grid data once the obstacle of lagging infrastructure quality is overcome. Finally, the potential of resulting innovation in precisely these domains would be bigger when no longer disadvantaged by unenforced regulations, and when embraced by adapted public procurement criteria

[84] For an overview of current issues surrounding peer to peer energy markets and their legal prerequisites here: https://fsr.eui.eu/peer-to-peer-trading-and-energy-communities/

Figure 26 Overview of main leverage points.



4.2 Governance of government

Whole-of-Government mobilisation

In order to achieve alignment in transition priorities and policies, e.g. via the above-mentioned holistic planning, it is important to involve all government domains and layers that may contribute to achieving the headline target (or, when not involved, even deploy initiatives that might go against it). The crafting and implementation of a coherent long-term strategy benefits from a 'whole of government'-approach to within-government coordination[85]. Characteristic elements of such an approach are *joined up policy making* (as a fundamental principle, rather than interagency work only in the stage of policy implementation), *boundary management* (e.g. on the national-regional interface, or between policy-makers and front-line/administrative personnel), *management of interdependencies* (e.g. between RES policies, EV policies and training policies), and *shared understanding* (for instance of the variety of complementary factors that get a transition going).

As already laid out, a suitable starting point for Greece would be the launch **a national mission for industrial development and the creation of quality employment**. To realise the promise of such a mission, it will be necessary to change the framing of industrial policy, graduating beyond support to sector-agnostic investment and for research and innovation (which need to be further strengthened in any case) to a mission-driven transition with ambitious objectives. Industrial policy will have to be extended beyond research and innovation to encompass the full panoply of policy tools in support of business investment and leverage all resources, including the spending budgets of households, businesses and government. In this new framing, the implicit competition for resources between ministries or between the policy objectives of environmental protection, a cohesive society and economic growth can be neutralised. Instead of competition, actually synergies can be promoted by exploring, discovering, and promoting those pathways that use the same resources to achieve all three: environmentally sustainable industrial development, which generates broad-based quality employment and, simultaneously, allows Greece to thrive in knowledge-intensive, internationally tradable sectors.

As a mission is time-bound, it can allow for some exceptional measures. Until the goals it sets out are met, the government could introduce **temporary policies to prioritise actions that favour alignment**. Consider for example, the introduction of a new criterion for public investments. In its simplest version, all public investments (with only few clearly specified and appropriately justified exceptions) would have to demonstrate relevance to the mission's goals (with specific reference to

[85] Colgan, A., Kennedy, L.A. and Doherty, N. (2014) A Primer on implementing whole of government approaches. Dublin: Centre for Effective Services.

employment-related objectives) and include investment components that enable synergies with realised or future public or private investments linked to the mission (e.g. industrial placements / skills development, public procurement of innovation). This way actions can be prioritised in view of their projected industrial development and employment impact. If implemented rigorously, the introduction of such a criterion would favour coordination and could ensure that most public investments combine under a coherent industrial development logic.

The whole-of-government drive of the national mission can be coupled with concrete commitments by stakeholders by developing **shared agendas.** Shared Agendas operate along shared interest lines and can be thought of as a bottom-up complement to missions. On the side of government, shared agendas can specify how the ambitions and support measures of different policy departments relate to each other. Often it can be difficult to determine which department would take the lead in drafting an agenda. As a matter of fact, the more it is clear that one particular department is in the lead, the harder it will be to get commitment from the other ones. The power of shared agendas is that they do not necessarily need to be purely policy-led, but can also be science, industry or society-led. The challenge then is to link the (top-down prescribed in the national mission) industrial transition's headline target to bottom-up initiatives that can actually carry the transition. The buy-in from stakeholders will be bigger when they have a say in determining what the transition will look like. For citizen representatives this could entail the provision on what type of sustainable transport solutions are provided over others. For firms, it would concern their view on the technologies they want to experiment with when contributing to the transitions. There is a big chance they will not be led by just the question how to realise the transition in Greece, but also by the export opportunities they see for the technologies they develop in this context. To maximise the involvement of firms that can provide useful innovations, the key is to identify commonalities between the interests the firms pursue and what is needed for the next steps on the transition path. Obtaining insights into the growth opportunities as identified by industry can be managed by deploying the *fora* mentioned in chapter 3, or by inviting firms (together with science and society) to develop *roadmaps* on the main opportunities and bottlenecks they see. Obviously, it takes some policy capabilities and institutional prerequisites to make such consultations an effective part of the shared agenda. For the Ministry of Economy and Investments this would mean they do not necessarily take the lead in writing an industrial transition agenda, but they would still need to be able to organize the process of involving stakeholders and balancing their priorities. Box 6 describes how this process was organised in the Dutch Top sector policy (which combines elements of both a national mission and thematic-sectoral shared agendas).

Box 6: Knowledge and innovation agendas in the Dutch Top sector policy

As of the 2012, the so-called Top sector policy makes up the Dutch national research and innovation strategy. At its core lie a total of nine Top sectors, representing major fields of scientific and economic strength. Each of the Top sectors has a top team of industry, science and government representatives.

According to a study published in 2019[86], "the Top sector approach entails a varied package of agenda-setting and networking interventions. For each domain, the top team decides what the innovation and human capital priorities are for the firms and research institutes it is representing. Every four years, the top teams make agreements with authorities and societal organizations as for what joint activities will be undertaken. Resulting knowledge and innovation agendas form the basis for a contract signed every two years by triple helix parties. [...] Joint research activities are performed in the Top consortia for Knowledge and Innovation (TKIs). Top sectors can have one or multiple TKIs. While there were 19 TKIs in 2011, the number is now back to 12 due to some consolidation. Besides those centres for applied research, also the Centres for Expertise and Craftsmanship are an important part of the institutional setup. These centres tune their educational programs to the human capital priorities of the respective Top sectors."

[86] Janssen, M. (2019). What bangs for your buck? Assessing the design and impact of Dutch transformative policy. *Technological Forecasting and Social Change.*

The governance of the Top sector policy follows design principles for ensuring that the knowledge and innovation agendas are truly ambitious and sufficiently backed by relevant stakeholders, in order to really ignite systemic changes. Some of the design principles match with elements of the whole-of-government approach. For instance, the prominent place for various high-level representatives aims to install leadership as well as networked governance, whereas the frequent interactions with policy officials have also introduced a more innovation-minded culture and the lining up of support provision across policy departments formerly not involved in innovation.

Also, other countries have implemented forms of 'new industrial policy'[87] in which governments designed governance structures that allow them to listen to what opportunities are about to be explored by primarily industry and science. Examples include the Catapult Centres in the UK, the Industrial Growth Centre Initiative in Australia, and the Strategic Innovation Programmes in Sweden. An often overlooked dimension of such 'network approaches' is that they also allow for the emergence *of new linkages* between policy domains. Instead of an economic development ministry reaching out to a health, environment or transport ministry, it is often via the industry-science platform that various policy domains get involved in innovation agendas. If the representatives of industry, research institutes and ideally also consumers, users and other citizens who stand to benefit from solutions to societal problems agree on certain development paths they want to explore, their appeal for facilitation or removal of legal barriers might meet more cooperation than when it is only a growth-oriented policy department trying to exert pressure. Involving different stakeholders in roadmaps and agendas is thus not just a possible way for Greece to further shape the development paths fitting its headline target; it can also be a vehicle for improving joint-up policy making and boundary management between ministries.

Monitoring and evaluation

When embarking upon the pursuit of a transition strategy, as outlined in a national mission and accompanying shared agendas, it is crucial to monitor to what extent the strategy is actually working. Indications that some system reinforcement or technology development/adoption processes are not working out might be reasons to change (parts of) the selected strategy.

Monitoring activities could in the first place concern the formulation and implementation of government interventions. Moving to a whole-of-government approach entails many changes, and it is very much possible to keep track of improvements and hurdles in envisaged governance adaptations. Especially when policy making follows and adaptive approach, responding to new innovation possibilities and evolving societal demands, there are good reasons to monitor (and regularly evaluate) governance arrangements and policy processes.

Looking at the dynamics that policies should engender, monitoring can also focus on progress in the development of (partial) solutions. Having insight in the speed at which technologies are being developed, produced and adopted may help decision makers to determine whether or not to intensify or abolish the support for a particular solution path. The focus of monitoring activities with this scope should be again on learning, for instance on the potential of different solution paths, how they interrelate, and the different types of support they might need. Monitoring results are most useful if it is possible to redirect policies based on information on how to best reach the chosen headline targets. Even when both the objectives and selected transition paths are maintained throughout the industrial transition, it is likely that policies need to change depending on the various bottlenecks at the subsequent stages of the transition paths. In Greece's case this could mean that the transition strategy could move from targeting smart grid solutions on islands (asking for e.g. regulatory changes or for sandboxes for regulatory experimentation) to remote areas (perhaps mainly demanding financial incentives) to urban areas (via for instance primarily infrastructure investments, and by co-opting business and household investments).

Finally, monitoring can play a role in tracking performance and outcomes directly linked to the headline targets (rather than the ways of getting there). Here that would be the RES share in transport,

[87] Rodrik, D. (2004). Industrial policy for the twenty-first century. *CID Working Paper*. Center for International Development, Harvard University, Cambridge, MA.

which is a clearly measurable indicator. The relevance of this type of monitoring increases if the overall indicator is deconstructed in underlying indicators, for instance by measuring the RES share in different types of transport or in different segments of society. At the moment, it is unclear which parts of the industrial system and which populations are supposed to contribute to the overall goal, so it is hard to revise policies. By contrast, if there would be sub-goals and corresponding indicators for e.g. RES consumption linked to EV use by different user groups (e.g. by location, vehicle type, institutional sector), it would be easier to get an understanding of where the transition currently stands and where the bottlenecks lie.

4.3 Building support coalitions

In order to effectively set transformations in motion, it is important to involve stakeholders that can contribute to the development and actual uptake of innovations that may lead to achieving the transition's headline target.

One promising way of uniting actors around a shared goal is to build a **support coalition**. Support coalitions consist of allying groups of stakeholders articulating their interests, exploring differences and commonalities, aligning priorities, and developing (or at least endorsing) an agenda for moving forward. As the development and deployment of novelty is likely to generate new insights and point at unforeseen tensions, this set of activities does not necessarily follow a linear step-wise process. Rather, it concerns an ongoing dynamic of exchanging ideas and negotiation.

Support coalitions are particularly powerful when they aggregate niches and connect them to more firmly rooted parts of society (like economic sectors or influential communities). Governments can catalyse the coordination amongst such disparate parties, and thereby build momentum for transition paths challenging the status quo.

The creation of a support coalition – promoting the direction of the transition – normally centred on a platform-like structure can extend involvement and facilitate alignment. The core of such a platform consists of stakeholders most actively pursuing the transition (including the government itself) or most directly affected by its consequences. By initiating dialogues and networking events the platform provides a basis for broadening the set of stakeholders involved in embracing and possibly contributing to the transition. Besides assembling a broad and powerful advocacy group, the platform also serves to develop activities through which this advocacy group can exert its influence. This would include, for instance, the mobilisation of funding sources or the creation of meeting and experimentation spaces in which participating stakeholders can explore the technical and economic feasibility of innovative solutions as well as the socio-economic consequences and regulatory demands they bring.

With respect to a support coalition in the case of the Greek industrial transition, there are possibilities to leverage experiences with participatory events tied to the Entrepreneurial Discovery Process (EDP). A next step would be to move beyond parties representing certain technology or business sectors, and also seek for participation of members active in for instance education or citizen movements. A suitable device for improving the general understanding of the challenges and opportunities of the transition towards RES-based transport is to shape a vision, translate it into a mission with a clear ambition level, and draw up a corresponding concrete shared agenda (see previous section) to which also non-directly involved stakeholders can commit. Which specific stakeholders this would be depends very much on the particular transition path that is being selected, but according to the perspectives underlying this review it is essential to cover representatives of the production as well as consumption sides of the pursued transformative change.

When building a support coalition around a shared goal, or mission, there are several tensions that may emerge when seeking to involve stakeholders[88]. For instance, opting for addressing only parties engaged with green public transport or private EV, without explicit attention for actors concerned with

[88] Janssen, M. J., Torrens, J. C. L., Wesseling, J., Wanzenböck, I., & Patterson, J. (2020). Position paper 'Mission-oriented innovation policy observatory'.

clean ports and shipping, would be a way to move quickly and install confidence in the government's potential to drive change. However, it might be hard to get the latter domain on board if later it turns out that valuable progress in RES-based transport may be achieved by linking the public transport and private EV trajectories to the one on electric ferries. Similar examples can be provided for the choice of one RES-type or distribution network over the other. More in general, there is a tension between involving many stakeholders (also within specific trajectories) versus moving forward with the keenest part of a certain trajectory. Leadership may conflict with democratic principles allowing stakeholders to have a vote in determining the transition's direction. Of particular interest here is the question how to deal with powerful incumbent firms or industry associations, like in a scenario in which the Greek transition would accelerate the wholesale abandoning of fossil fuels. Having incumbents side with the support coalition could boost its clout, whereas opposing them might slow down progress substantially. Therefore it is recommended to consider involving such groups in the coalition as well, to at least be able to address their concerns and possibly co-opt them (see also next section on Managing resistance to change).

4.4 Managing resistance to change

Passive resistance: inertia

Transitions are about overcoming resistances, with part of the resistance coming from inertia in the existing system. The present production and consumption subsystems are not only deeply entwined with each other, but also with 'socio-technical regime' aspects like culture, policy and science. For instance, on the culture aspect, the widespread demand for car ownership will make it relatively hard to move to (urban) mobility solutions based on fleets of electric cars that can be leased or shared. Apart from solving all sorts of technical and financial issues, (industrial) transition management thus also involves being responsive to local norms and values. In the context of RES use this also concerns attitudes regarding energy security and price, which are often deemed more important than sustainability. Instead of counting on unanimous enthusiasm for sustainable energy services, transition plans will necessarily have to consider that for instance on the islands the priorities of citizens currently lie with very different social concerns. Besides 'soft institutions' like **norms and values**, there are also harder institutions to take into account, like **regulation** and **infrastructures**. This includes the repeatedly discussed regulation for energy production by private households, firms and local energy communities in conjunction with grid access and the possibility to trade locally produced energy. Furthermore, in many places the energy infrastructure itself is currently not ready for prosumers. Similarly, inertia arises from the mobility system being geared towards fossil fuels, which limits possibilities to also establish an EV charging network. Resistance can also be the result of insufficient consultation and involvement of local communities in large investment projects, as demonstrated by the active resistance to the introduction of large wind farms in some Aegean islands[89].

While resistance due to soft institutions can be mitigated by sufficiently involving affected stakeholders (e.g. in the shared agendas described earlier), some of the regulatory and infrastructural resistance factors can be alleviated directly via top-down policies. For instance, both national and regional authorities are in the position to make decisions on the energy grid and on the rules or exemptions regarding grid usage. Promoting regulatory innovation, and granting a mandate as well as resources, to the Energy Regulatory Authority (RAE) for the promotion of experimentation (see Box 4 on p. 811) and innovation can catalyse developments.

Active resistance: ensuring clear benefits for those who have the most to lose

Already from the outset it is known that the region of Western Macedonia will be heavily affected by inevitable international developments, and Greece's commitments, and the government's ambitions, to make a drastic switch towards more sustainable energy production. Moving away from lignite mining will probably have a major negative impact on the regional economy. This makes the key

[89] https://www.theguardian.com/world/2020/jun/11/backlash-grows-over-greek-energy-deregulation-law

challenge of the industrial transition to not only succeed in enhancing RES use, but to also find an answer for the mining jobs that get lost. It is worth noting that many of the identified opportunities to make Greece meet its headline targets might perhaps contribute to economic activities around battery production and EV solutions, but not all of them will be easy to locate in Western-Macedonia. For instance, transition paths focused on RES-based islands, clean shipping or urban public transport will hardly leave any room to be anchored in Western-Macedonia. Apart from perhaps some R&D and production, all usage and maintenance related activities would need to be based near the islands and cities themselves. To mediate resistance due to **uneven regional growth**, it is important to sufficiently involve Western Macedonia in the transition strategy. One way to do so is by identifying transition paths that contain labour- and perhaps land-intensive production activities, like the production of biomass. Biomass may be used to smoothen the transition from fossil fuel to RES-based electricity. An alternative is to consider complementary strategies beyond the main RES-oriented transition paths themselves. The suggestion mentioned in section 3.3.2 is the adoption of an ambitious strategy to turn Western-Macedonia into an internationally renowned knowledge producer and demonstrator region for environmental remediation and associated technologies. When resources are made available, for instance by redistributing some of the revenues from transition successes elsewhere (in addition to EU funds in support of coal regions, including as part of the European Green Deal), Western Macedonia might be able to pioneer approaches for restoring landscapes affected by heavy mining activities, which have the additional advantages of : (i) capabilities overlap with some forms of RES (e.g. geothermal) and energy storage (e.g. pumped hydro) and: (ii) they further boost the development of sectors depending on the natural environment, such as agriculture and tourism. Future-proofing such a strategy would require extensive local innovation activities, vocational skills provision, and targeted incentives for investments resulting in the development of productive capabilities in proximate construction, metalwork natural resource management niches. Importantly, the **green** direction in the region's strategy can provide a degree of reassurance that the environmental excesses of the past will not be repeated. Such reassurance may allow securing the broad citizen backing necessary for the region to be a first mover into the complementary and potentially lucrative activities of sustainable waste management and recycling. As part of such a path, obsolete industrial sites could be exploited for e.g. the reuse, recycling and/or sustainable disposal of green technology waste. This becomes particularly interesting when such waste management activities can be linked to the main transition paths regarding RES production and usage. In this case productive loops might emerge when the Western-Macedonian green technology recycling industry can start off with waste from the RES-solutions in the urban and island areas, and extend this to also collecting and recycling used photovoltaics, wind turbines etc. from other countries. Moreover, used green technologies transported, imported to and recycled/remanufactured in Western-Macedonia might perhaps also find a second life as part of the RES-based transition paths in Greek cities and islands. Benefitting from such interdependencies between different technological and sustainability-focused development paths typically involves extensive coordination between various regions and policy fields, hence the emphasis on holistic planning as discussed in section 4.1.

Apart from resistance possibly located in specific regions, there is also a chance of encountering counteracting activities from more sectoral constituencies or even individual stakeholders (like firms) affected by the transition. In the case of major **incumbent firms** like Sunlight Systems, this risk can be overcome by ensuring that the transition also offers new possibilities. As Sunlight obtains most of its revenues from exports, the local market is probably primarily interesting for offering opportunities to experiment with new technologies / applications and learn with and from customers. In that sense, it might be good news if Greece is moving forward in the use of battery-based RES solutions. This holds especially if the transition spawns firms specialised in developing, transporting, integrating, maintaining and recycling different types of battery technologies. Even if some of these activities focus on battery technologies not provided by the incumbent player, it is likely that the latter will benefit from a better populated value chain (or even ecosystem; see section 4.1).

Finally, as for the industries closely linked to the **'sunset regime'** of fossil fuel based energy and mobility, the speed at which they will feel threatened is probably not so high that active resistance

can be expected at short notice. It is likely that even when optimistic scenarios on electrified transport become true, there will still be plenty of demand for retail and maintenance of combustion-engine powered cars, buses, boats, and etcetera. In the new regime there might be less employment in adjacent sectors, as electric vehicles typically demand less maintenance than those based on combustion engines. A solution to prevent an unbalanced labour market is to involve employees from the sunset regime sufficiently in vocational training initiatives like the regional 'field labs' mentioned throughout chapters 3 and 4.

4.5 Defining experiments, reforms, policies and instruments

Together, the reflections and recommendations provided in the previous sections offer directions for the development of some concrete institutional reconfigurations, experiments and policies. The overall objective of such interventions should be to capture 'structural opportunities'[90], emerging from nurturing development trajectories in which public and private investments (in research, human capital, infrastructures etc.) complement each other. Besides such complementarities being the key to increasing economic returns from investments, they are also essential for overcoming the inertia hampering transformation of the existing production-consumption system. Stated differently, realizing Greece's industrial transition is not just a matter of solving market failures in the battery, energy or mobility sector, and neither of only improving system failures related to interactions amongst the various knowledge producing and applying stakeholders; it is also a matter of addressing the 'transformational failures'[91] that prevent innovative efforts to accumulate and gain sufficient critical mass for transitioning to a more sustainable production-consumption system. To a large extent, this boils down to implementing coordination mechanisms that unleash complementarities by providing clear directionality regarding the transition paths viable for meeting the headline targets.

Revised governance structures

First, there is the challenge of devising governance structures that allow for the **coupling of technological and socio-economic developments** that could shape a coherent transition path. As noticed, this requires holistic planning based on a profound understanding of the specific possibilities resulting from Greece's set of capabilities, demands and institutions. Since it is virtually impossible to monitor this from within the government only, alternatives that should be considered include governance structures providing an active voice to stakeholders that can help shaping the transition (both when it comes to production as well as consumption). Such a setup would entail an extension of practices associated with smart specialisation strategies (S3). A difference between industrial transitions and S3 is that, apart from being geared to specifically *sustainable* development paths, industrial transitions with a headline target like Greece should also be more sensitive to the *socio-economic* aspect of diffusing new technologies. Moreover, an industrial transition strategy should acknowledge the existence of potential synergies or tensions regarding the *various paths* that could lead to the desired outcomes.[92] Although presenting some fundamental differences at the strategic level, in operational terms it can still be possible to rely on **tools** that have proven to be relevant for supporting the entrepreneurial discovery process (EDP) in a S3 setting[93]. Some of the tools that might be particularly suitable in the Greek situation are:

- **Governance working group.** Within the S3 context, Greece has already gained experiences with a bottom-up approach to defining joint strategies and roadmaps. The crucial element of

[90] Andreoni, A., Scazzieri, R. (2014). Triggers of change: structural trajectories and production dynamics, *Cambridge Journal of Economics*, 38, (6) 1391–1408

[91] Weber, K.M., & Rohracher, H. (2012). Legitimizing research, technology and innovation policies for transformative change: combining insights from innovation systems and multi-level perspective in a comprehensive failures framework. *Research Policy*, 41, 1037–1047.

[92] There are for instance different ways to realize clean shipping (e.g. via electrification, LNG, ammonia, or hybrid solutions), but these ways are not necessarily compatible with each other or with sustainability-oriented adaptations of circular ports. In lack of sufficient interaction or even orchestration, there is a chance of the shipping sector moving into a different direction than the ports in which they harbour. Reversely, when properly aligned, seemingly parallel investments can catalyse each other.

[93] Boden, M., dos Santos, P., Haegeman, K., Marinelli, E., & Valero, S. (2016). Implementing RIS3 in the region of Eastern Macedonia and Thrace: Towards a RIS3 tool box. *JRC S3 Policy Brief Series, 20*.

such working groups is to involve a broad set of policy makers not just in the development of the strategy, but also in the implementation stage. In this case the relevant range of policy makers goes beyond the domains of economy, investment, finance, research and education; to ensure the uptake of promising battery-based EV solutions it is recommended to also engage representatives from fields like energy, energy-intensive industries (as users/consumers), transport and even fields heavily relying on fleets of vehicles (like the police, army and health domains). As noted earlier, these policy fields can play an important role by utilizing their demands, procurement processes and partnership possibilities to accelerate the adoption of desirable innovative solutions in the RES-transport nexus.

- **Stakeholder round table discussions / online stakeholder engagement.** Ideas on which technologies and innovations to incorporate in the transition path require the type of technical and commercial knowledge held by market players themselves. After all, it is the task of the business sector to connect insights on technological possibilities with insights on market opportunities. Policy makers might be able to steer and accelerate the innovation process, but it will usually be firms that bring forward the specific solutions that can form a sustainable production-consumption system. To retrieve such information, a combination of round table discussions and online stakeholder engagement processes may be considered. The goal would be to outsource part of the government's intelligence function to industries (and science) itself, in order to feed policy makers with their view on the most promising ways of organizing the transition. As the envisaged industrial transition strategy does not only target the invention and production of new solutions, but also the diffusion, the set of relevant stakeholders to involve is broader than in a typical S3 setting. Which parties represent the demand side best depends to a high extent on the specific transition path that is being chosen. Use cases of relevance to the RES-transport nexus include energy-intensive industries (including e.g. cement manufacturing), public transport (including taxis), short-range shipping, rooftop photovoltaic (in businesses, households, including apartment blocks) etc.
- **Online Research, Development and Innovation (R&D&I) Funding Guide.** Given that businesses have expressed a demand for a digital one-stop-shop for clarifying funding opportunities, it might be relevant to have a look at all the already developed funding guides as part of the S3 approach. Digital one-stop-shops could be more than just a well-structured guide when also containing an interactive element, e.g. when it facilitates Q&A between businesses themselves, or also with the financers listed in the guide. Again, it is important to extend the scope from R&D&I to also funding options targeting the adoption of solutions. In the case of RES and battery-based mobility, this could include potential support schemes for the purchase of EVs, EV charging infrastructure, or even the electricity itself. Large investments will be needed in energy storage. Grid scale storage solutions see an important role for pumped hydro, as well as stationary batteries, both solutions that require large amounts of finance and which may call for burden and risk-sharing in the form of public-private partnerships.
- **Collaboration spotting tool.** Finally, it is important to note that the industrial transition combines an economic logic (boosting diversification towards competitiveness-enhancing and job-creating activities) with the logic of addressing a societal challenge like decreasing fossil fuel use and improving human health. This duality emphasizes that it is not essential that all technologies featuring in the transition path are produced locally. Already in a regular industrial strategy it might be strategic to outsource part of the value chain in which a new economic activity is situated, but the focus on actual adoption now also implies outsourcing might be wise (e.g. to cost considerations) even if it does destroy some commercial opportunities for the Greek industry. Making decisions of this kind is an eminent example of a task requiring detailed information about production possibilities and opportunities, again making the case for governance structures like the working groups and roundtable discussions that continuously gather relevant intelligence to inform a wide cross-section of decision makers. When deciding to engage in strategic collaboration in order to be able to

make the shift to a coherent transition path, it is crucial to oversee which partners (firms/regions/networks) might provide the missing pieces. In this respect, it is possible to use resources like the collaborating spotting tool developed by CERN-JRC[94]. It concerns a quantitative visualisation tool for identifying potential international R&D partners in specific cooperation areas.

In addition to these S3-based tools, there are also other practices that can be taken as an inspiration for setting up the coordination and acceleration activities that can drive Greece's industrial transition. One of the examples discussed prominently in this review are the Lifelong Learning Centres, which might be extended to **regional field labs** by combining vocational training with public-private experimentation and demonstration activities. Although there are good experiences with this approach already in regions like Western-Attica, other countries might provide some additional insights on how to organize the field labs. For instance, a 2017 call for 'smart industry' field labs in the Netherlands has led to the launch of now 45 centres in which business and knowledge institutes strengthen each other.[95] The centres are all focused on a production technology in relation to ICT (e.g. 3D printers, robots, drones, sensors), although some focus on intangible issues like business model innovation and servitisation. With government support of maximum €3m, the centres organise activities like the development, testing and implementation of new technologies. An important feature is that the involvement of applied universities allows firms to get in direct contact with the institutes (and students) that should help them with obtaining the skills they need to keep up or even lead the developments in their sector. Due to the bottom-up character of the centres' activities, also on the education side, there is a high variety in experiences Greece might benefit from.

Policy experiments

Besides initiating interventions along the high-level but rather pragmatic lines sketched above, the Greek industrial transition may also benefit from a more experimental approach to exploring new solutions. Attention for running **small-scale experiments** is not just in line with the search for evidence-based policies, but also with the emerging view on transformative innovation policy[96]. According to this view it is important to go beyond piloting just technologies; the learning process should also shed light on viable business models, legal contracts, legitimacy of the solution, required skills, and linkages with other parts of a production-consumption system. Such a contextual focus demands a participatory and iterative approach rather than a uniform rigorous testing of one single solution.

Following these principles, it is recommended to develop small-scale and low-cost experiments that focus on for instance the major bottlenecks that keep an almost market-ready solution from diffusing further. Content-wise, the most promising opportunities reside in testing solutions that might be commercialised internationally. This links back to the strategy of searching 'niches' that offer particularly favourable conditions for experimenting, due to specifically strong local capabilities or needs (see sections 8 and 15). One example would be an experiment with electric ferries; Greece hosts a specialisation in both batteries as well as passenger/cargo shipbuilding, and due to its many islands also has a geography inviting for the use of ferries. This combination can also be linked with the observation that islands themselves act as niches, in the sense that they are shielded environments in which some demands are highly above average (e.g. vehicle ownership) and others below average (EV range requirements). A situation like this would lend itself for testing solutions like electric ferries partially fuelled by – or charging – electric vehicles. At the moment there are already several deep demonstration projects going on, e.g. on ports, mobility and sustainability. More impact can be achieved by offering funding support for upscaling and rolling out nationally, as discussed in section 9. Besides driving transformative change by trying new things at the local level, it is also possible to experiment with the overarching structures used for driving and uniting innovative

94 http://collspotting.web.cern.ch/

95 https://smartindustry.nl/fieldlabs/

96 Schot, J. & Steinmueller, E. (2019). Three frames for innovation policy: R&D, systems of innovation and transformative change. *Research Policy, 47*, 1554-1567.

activities. An approach rapidly gaining attention is the use of **missions**, which also provides promising opportunities for the Greek transition (see section 13, Box 4).

5 References and Data

5.1 References

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5.2 Data

Table 8 A snapshot of the system under transition.

Scientific fields	Relevant Patent Classes	Products / Artefacts and/or Services	Market Actors and NACEv2 Codes	State Actors
Batteries and Fuel Cells: Materials Science, Electrochemistry, Surfaces Coatings and Films, Chemical Engineering	**Batteries and fuel cells**: Y02E, Y02P, Y02T, H02J, H01M	Fuel cells; Primary cells and primary batteries; Parts of primary cells and primary batteries; Electric accumulators and parts thereof; Nickel-cadmium, nickel metal hydride, lithium-ion, lithium polymer, nickel-iron and other electric accumulators; Parts of electric accumulators including separators; Sub-contracted operations as part of manufacturing of batteries and accumulators; Sub-contracted operations as part of manufacturing of batteries and accumulators	07.29 Mining of other non-ferrous metal ores; 20.59 Manufacture of other chemical products n.e.c (n/a) **27.20 Manufacture of batteries and accumulators** 38.11 Collection of non-hazardous waste 38.21 Treatment and disposal of non-hazardous waste 38.32 Recovery of sorted materials 72.19 Other research and experimental development on natural sciences and engineering	Government and Agencies: • Ministry of Environment and Energy • Ministry of Finance • Ministry of Infrastructure and Transport • Ministry of Economy and Development • Regulatory Authority for Energy (RAE) • Centre for Renewable Energy Sources and Saving (CRES) • Hellenic Energy Exchange S.A. (HEnEx SA) • Renewable Energy Sources and Guarantees of Origin • Independent Power Transmission Operator (ADMIE) S.A. • Hellenic Electricity Distribution Network Operator (HEDNO) • General Secretariat for Research and Technology (GSRT) European Commission (relevant DGs) • Energy • Environment • Research • REGIO
Grid Management: Electrical and Electronic Engineering, Energy Engineering and Power Technology, Energy and Fuels, Renewable Energy Sustainability and Environment, Control and Systems Engineering, Computer Science	**Grid Management:** G06Q, Y02T, Y04S, Y02E H02J, B60L **EV Charging Infrastructure**: Y04S, Y02T, B60L H01M, G06Q **Renewable & distributed power integration**: G06Q, Y02B, H02J, Y04S	Energy Communities; Residential energy generation/ management systems; Gas, liquid or electricity supply or production meters; Electricity distribution and control apparatus; Energy Storage; Ultra capacitor; Vehicle to Grid (v2G)	**35.11 Production of electricity** **35.14 Trade of electricity** 72.19 Other research and experimental development on natural sciences and engineering	
Wind Energy: Mechanical Engineering, Aerospace engineering, Mechanics, Materials and Composites, Civil and Structural Engineering	**Wind Energy**: Y02E, F03D, F05D, H02J.	Wind turbines; Parts for other engines n.e.c.; Sub-contracted operations as part of manufacturing of engines and turbines, except aircraft, vehicle	**35.11 Production of electricity** **35.14 Trade of electricity**	

Scientific fields	Relevant Patent Classes	Products / Artefacts and/or Services	Market Actors and NACEv2 Codes	State Actors
		and cycle engines; Gears and gearing; ball or roller screws; gear boxes and other speed changers; Engineering services for power projects;	72.19 Other research and experimental development on natural sciences and engineering	Finance: • Greek banks; • European Investment Bank; • World Bank; • Private Investors; • Investment Management Firms Public Research: • Research Centres: CERTH, ICCS/NTUA, FORTH, NCSR DEMOKRITOS; • HEIs: NTUA, Aristotle Univ Thessaloniki, Demokritus Univ Thrace, U Ioannina, U Patras Major Urban Transport Organisations: • OASA (Athens) • OASTh (Thessaloniki)
Photovoltaics: Materials Science; Materials Chemistry; Surfaces, Coatings and Films; Atomic and Molecular Physics and Optics; Chemical Engineering; Electrical Engineering; Renewable Energy, Sustainability and the Environment; Energy Engineering and Power Technology	Y02E; Y02P; H01G; F24S	Semiconductor devices; light-emitting diodes; mounted piezo-electric crystals; parts thereof; Engineering services for power projects; Photovoltaic electric vehicle charging; photovoltaic grid charging;	**35.11 Production of electricity** **35.14 Trade of electricity** 72.19 Other research and experimental development on natural sciences and engineering	
Biofuels: Applied Microbiology and Biotechnology; Biotechnology; Bioengineering; Fuel Technology; Energy Engineering and Power Technology; Environmental Chemistry; Renewable Energy, Sustainability and the Environment; Chemical Engineering	C10G; C12N; C12M; C12P; C10L; Y02A; Y02P; Y02E;	Biodiesel; Bioethanol; Biogas; Algae biofuels; Hydrogen from biomass; lignocellulosic biofuels; Anaerobic digestion; bio-photochemical conversion; biomass gasification; enzymatic hydrolysis; fermentation; pyrolysis of biomass;	**19.20 Manufacture of refined petroleum products** **20.59 Manufacture of other chemical products n.e.c.** 46.71 Wholesale of solid, liquid and gaseous fuels and related products 47.30 Retail sale of automotive fuel in specialised stores	
e-Mobility: Geography, Planning and Development; Renewable Energy, Sustainability and the Environment; Electrical and Electronic Engineering; Mechanical Engineering; Civil Engineering; Computer Science; Information Systems; Automotive Engineering; Artificial Intelligence; Transport Engineering		Servicing of electric cars; all electric range, all electric ship all electric vehicle; battery powered vehicle; vehicle charging station; Other motor vehicles for the transport of persons; Motor vehicles for the transport of 10 or more persons; Motor vehicles for the transport of goods; Vehicles for travelling on snow, golf cars and the like, with	29.10 Manufacture of motor vehicles 45.00 Wholesale and retail trade and repair of motor vehicles and motorcycles 46.71 Wholesale of solid, liquid and gaseous fuels and related products 47.30 Retail sale of automotive fuel in specialised stores 49.10 Passenger rail transport, interurban 49.20 Freight rail transport	

Scientific fields	Relevant Patent Classes	Products / Artefacts and/or Services	Market Actors and NACEv2 Codes	State Actors
		engines; Special-purpose motor vehicles n.e.c.; Rail locomotives powered from an external source of electricity; Motorcycles n.e.c.; side-cars; plug-in electric vehicle (pev); plug-in hybrid electric vehicle (phev);	49.3 Urban and suburban passenger land transport 49.32 Taxi operation 49.39 Other passenger land transport n.e.c. 49.4 Freight transport by road and removal services 50.10 Sea and coastal passenger water transport 50.20 Sea and coastal freight water transport	

Table 9 Structural Business Statistics of the major NACE codes that are relevant to this review in 2016 (source: EL.STAT).

NACEv2	Description	Legal Entities	Turnover (mil EUR)	Employ-ment
19.2	Manufacture of refined petroleum products	35	12 510	3 561
20.5	Manufacture of other chemical products	168	394	1 458
27.2	Manufacture of batteries and accumulators	13	177	638
29.1	Manufacture of motor vehicles	14	7	414
35.1	Electric power generation, transmission and distribution	6 369	18 114	31 295
38.1	Waste collection	440	264	3 083
38.2	Waste treatment and disposal	103	153	1 872
38.3	Materials recovery	203	262	1 969
45.1	Sale of motor vehicles	2 494	3 494	11 593
45.2	Maintenance and repair of motor vehicles	14 640	946	32 296
45.4	Sale, maintenance and repair of motorcycles and related parts and accessories	2 487	410	5 312
46.7	Other specialised wholesale	12 926	15 334	42 075
47.3	Retail sale of automotive fuel in specialised stores	4 981	6 244	17 197
49.1	Passenger rail transport, interurban	9	262	943
49.2	Freight rail transport	5	12	33
49.3	Other passenger land transport	35 052	1 464	70 882
49.4	Freight transport by road and removal services	17 083	2 315	36 493
50.1	Sea and coastal passenger water transport	1 411	1 224	8 776
50.2	Sea and coastal freight water transport	567	775	7 851
72.1	Research and experimental development on natural sciences and engineering	4 200	305	10 887

Table 10 Top 10 sectors with job gains and losses (source: JRC, based on Eurostat data: https://ec.europa.eu/eurostat/web/products-datasets/-/sbs_na_sca_r2).

Top 10 sectors with job gains					
NACE REV 2		Average annual change (2008-2017)		Change 2017 versus first year available	
Code	Description	Value	Ranking	Value	Ranking
E38	Waste collection, treatment and disposal activities; materials recovery	94,1%	1	472,5%	1
N78	Employment activities	24,0%	2	100,0%	4
J63	Information service activities	16,0%	3	140,2%	2
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	12,1%	4	49,2%	9
H55	Air transport; accommodation; travel agency, tour operator reservation service and related activities	9,4%	5	101,7%	3
H56	Food and beverage service activities	7,1%	6	66,4%	5
L68	Real estate activities	6,7%	7	50,2%	8
M75	Veterinary activities	6,4%	8	59,3%	6
J62	Computer programming, consultancy and related activities	6,3%	9	55,6%	7
E39	Remediation activities and other waste management services	4,9%	10	24,6%	10

Top 10 sectors with job losses					
NACE REV 2		Average annual change (2008-2017)		Change 2017 versus first year available	
Code	Description	Value	Ranking	Value	Ranking
F41	Construction of buildings	-14,5%	1	-64,3%	2
J58	Publishing activities	-10,8%	2	-65,9%	1
C29	Manufacture of motor vehicles, trailers and semi-trailers	-8,8%	3	-62,5%	3
C14	Manufacture of wearing apparel	-8,5%	4	-57,5%	4
C13	Manufacture of textiles	-7,5%	5	-52,0%	8
C16	Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	-7,1%	6	-54,1%	5
C28	Manufacture of machinery and equipment n.e.c.	-7,0%	7	-49,0%	12
M74	Other professional, scientific and technical activities	-6,9%	8	-53,2%	6
C30	Manufacture of other transport equipment	-6,2%	9	-50,5%	10
J60	Programming and broadcasting activities	-6,1%	10	-51,1%	9

Figure 27 Map of critical raw materials in Greece. Source: Greek Institute of Geological and Mineral Exploration.

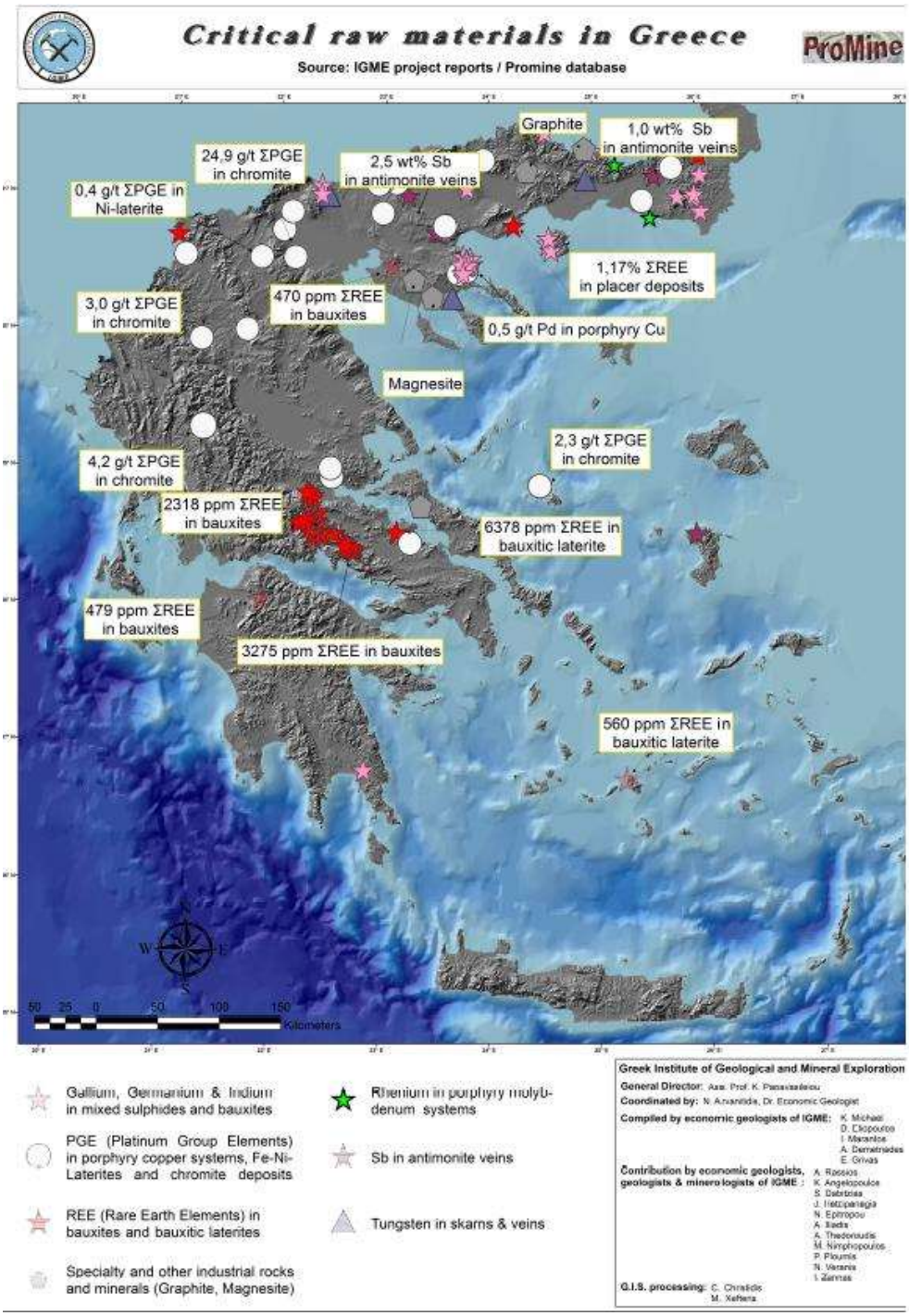


Figure 28 Wind potential at h100 (source: RAE).

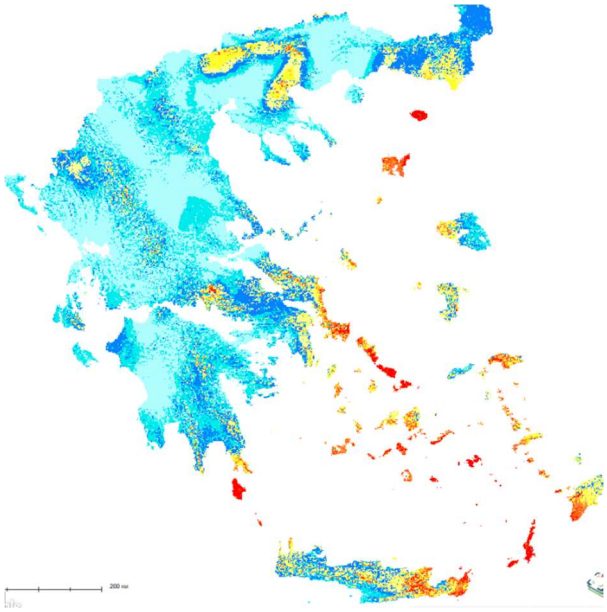


Figure 29 Spatial distribution of Wind parks. Yellow dots indicate applications for new installations under evaluation. (source: RAE)

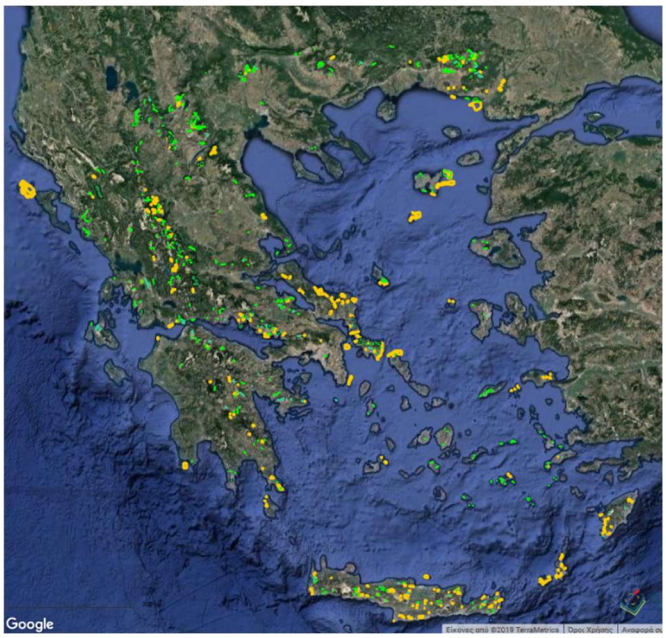


Figure 30 Spatial distribution of small hydro plants. Yellow dots indicate applications for new installations under evaluation. (source: RAE)

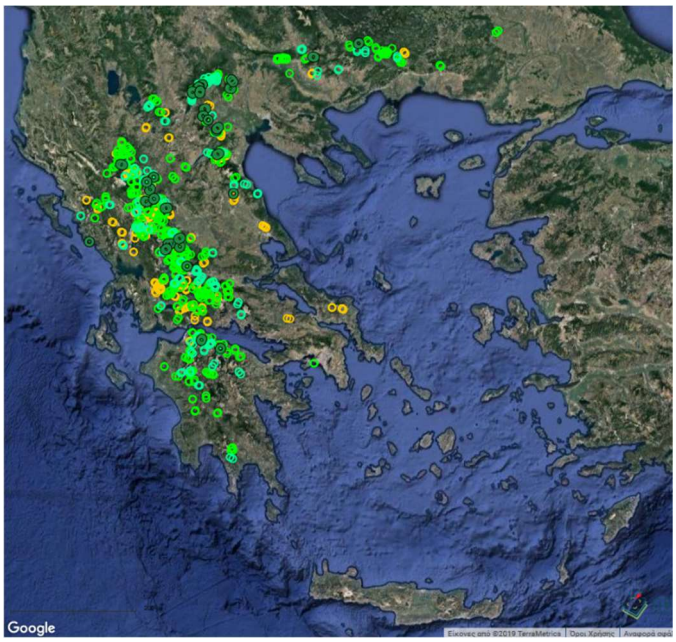
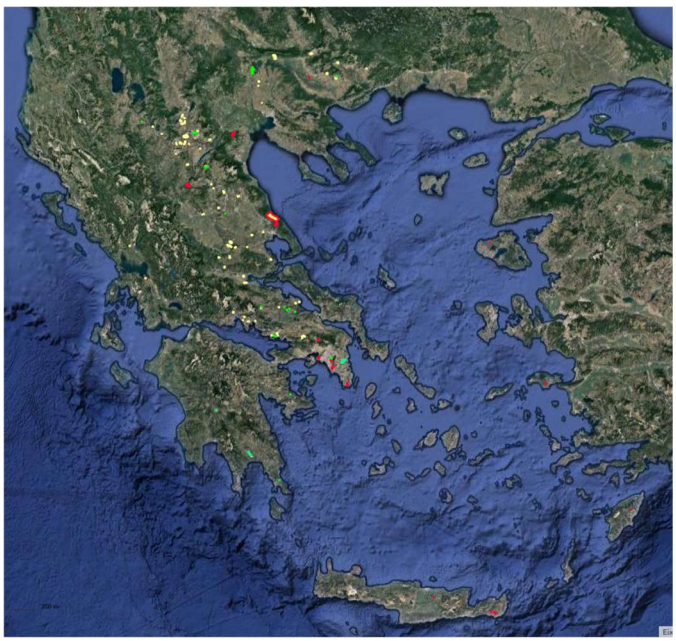


Figure 31 Photovoltaic installations of more than 1 MW. Yellow dots indicate applications for new installations under evaluation. (source: RAE)



6 B. Summary of Findings and Recommendations

6.1 The Current and Future State of the System

Planning and Orientation

The highly ambitious Greek National Energy and Climate Plan (NECP) that is already under deployment is benefiting from strong political support from the Prime Minister's Office and the Cabinet and the recommendations of visionary experts in academia and industry. Although this might partially compensate for the lack of a clear overall framework for coordination in the range of portfolios impinging on the transition, there is still much to be done to align policy with the logic of industrial development, engage a wider base of stakeholders such as the regional and municipal administrations into the process, draft more specific plans and introduce an integrated monitoring system. A clear and succinct definition of 'industrial transition' that can be easily communicated and understood is also still missing. The Ministry for Development and Investment will probably have a central role in putting the transition into the policy agenda and mobilising the budgets earmarked by the European Structural and Investment Funds, the InvestEU programme and the Just Transition Mechanism. The tested consultation and coordination mechanisms that are currently in place within agencies of the Ministry of Development and Investment will have, however, to be swiftly executed so that policy instruments are deployed as soon as possible, performance is monitored and corrective action is taken, if needed. Moreover, if a consensus is to emerge on the transition paths, conflict resolution tactics have to be put in place to address tensions between strong vested 'carbon economy' interests and 'green economy' lobbies.

Resource Mobilisation

Apart from the EU funding mentioned in the previous paragraph, the transition will require **resource mobilisation** from additional sources. Although there is abundance of capital ready to be invested at the global level, Greece has historically faced difficulties in attracting foreign direct investment due to, among others, cost of capital associated to political risk, over-regulation, bureaucracy and rule of law. The national financial sector is weak, suffering from the effects of the 10-year long financial crisis and public investment is constrained by the need to service excessively high external debt. Therefore, leveraging private investment by utilising EU funding in effective policy schemes and removing barriers to foreign direct investments should be considered as the top options. The public procurement of innovation, an instrument that has not been deployed in Greece so far, can also be considered in stimulating developments along the transition pathways, such as in mainstreaming successful pilot projects of high relevance to the transition and in establishing pockets of best practice in public transport or in ports. Regarding human resources, the Greek higher education system is producing ample numbers of high-quality STEM graduates. However, both the chronic misalignment of education system with the market needs and the results of the financial crisis have led to brain drain in the order of hundred thousand since 2008. Moreover, despite the policy interventions funded by the European Social Fund, both vocational training and life-long learning are underperforming while in-firm training is effectively non-existent.

Production

Our analysis of the industrial sectors which are relevant to the transition has shown that, with the exception of very few start-ups in the fields of hydrogen and photovoltaics, the **production** subsystems of knowledge and of goods/services follow entirely different trajectories. Although more than six thousand entities are registered as energy producers, production and trade of electricity is still dominated by a large incumbent in dire financial situation and around five new entrants that actively seek market share in a market that, judging from the cost of energy, does not seem to be efficient. Digitisation is extremely limited in the sector, and regulation puts significant barriers to the strong Greek ICT sector to introduce much needed innovations. Although there is significant potential for producing electricity from biomass or household waste and thus create economic spillovers to other sectors of the economy, wind and photovoltaics are the major renewable energy sources in the

Greek system, with the former having big potential for further contribution if the islands in the south-east of the country are interconnected to the backbone network. The battery industry is dominated by a single player that serves niche international markets for custom-made batteries. Although battery recycling systems are in place, the relevant actors focus on recycling lead for car batteries; used li-ion batteries are exported to be recycled abroad. Business to business and business to academia networks in renewable energy sources, batteries and intelligent transport seem to be weak. The Greek scientific base in electrical and environmental engineering is strong. Public research organisations dominate in terms of shares of competitive funding, without finding pathways to commercialise their research outputs. The involvement of enterprises in national and EU-funded collaborative research projects is small. Therefore, gearing the knowledge production system to the needs of the transition is of primary importance.

Consumption

The final energy **consumption** in Greece in 2017 was 186.7 TWh, of which 19.3% were consumed by industry, 36.2% by transport, 27.5% by households and 15.6% by services and the primary sector. Recent opinion surveys indicate that affordability of electricity is the major issue for both households and industry. The successful case for the widespread diffusion of solar water heaters funded by individual small-scale investment and tax breaks suggests that such schemes are compatible with the norms of the social system in Greece. The recent surge in positive attitude towards electric mobility coupled by a high average age of all types of vehicles indicate that accelerated adoption of electric vehicles is ready to happen, if the main consumer worries on pricing and charging infrastructure are addressed. Successful demonstration projects have indicated that small islands that are not interconnected to the mainland electricity grid, are archetypical niches for deploying integrated renewable energy production, storage and electric mobility.

6.2 Accelerating the Transition

Leverage Points

Based on the analysis of the current and the desired system, there are various leverage points that offer a basis for policy intervention:

- **Holistic planning**. Across Greece there are many initiatives that could be integrated into a coherent national mission. This includes the policy actions following from the NECP and the Greek Green Pact, as well as initiatives by regional policy makers or industry to update capabilities and/or to adopt sustainable technologies.
- **Catalysing innovation via procurement (PCP/PPI).** Precommercial procurement of innovation (PCP) and public procurement of innovation (PPI) allow authorities to mobilise their resources and position to give an impulse to societally desirable innovative developments. While there is some experience with this already, it is advised to intensify PCP/PPI priorities, resources and capabilities by a broad range of Greek authorities regulating or procuring energy and transport solutions.
- **Regional thematic 'field labs' for vocational training and research & innovation**. Capability development and economic development can be combined in regional field labs like Greece's Lifelong Learning Centres, involving both (applied) research / education institutes as well as companies. Inviting firms to articulate their skill demands and co-define the theme of the training centre ensures that provided trainings correspond with market needs. The centres also confront firms with the ideas and skills of institutes and other firms.
- **Ecosystem development**. Another leverage point is to develop stronger ecosystems focused on enhanced interaction between knowledge institutes and firms. There are various (complementary) modes that can be envisaged here, including ecosystem development around strong research organisations such as CERTH or ICCS/NTUA, around strong industrial

players such as Sunlight Systems, and around existing cluster of smaller firms such as the Cluster of Bioeconomy and Environment of Western Macedonia (CLuBE).

- **Smarter and better energy infrastructures.** Since many parts of the Greek energy grid are in need of maintenance, improvement and digitization, there is an opportunity to combine this with installing the meters and techniques that allow for local energy production, and possibly peer-to-peer energy transactions, as well as detailed and real-time data collection on energy production and energy use. The latter is regarded as an essential prerequisite for the emergence of new RES-based solutions and business models.
- **Enforcing (and improving) environmental protection**. A relatively simple but effective way to drive the transition is to ensure that regulation for protecting the environment is enforced more strictly. Levelling the playing field through intensified enforcement would at the same time encourage investment and innovation for sustainable solutions, allow associated markets to grow and improve protection of the environment.

Following the principle of holistic planning, most likely the benefits from pursuing the individual leverage points can be enhanced when also linking them to each other. The field labs could for instance be a component in a strategy for targeting ecosystem development. When focusing on topics like innovative energy services or private EV, it also links to the driver of utilising smart grid data once the obstacle of lagging infrastructure quality is overcome. Finally, the potential of resulting innovation in these domains would be bigger when no longer disadvantaged by unenforced regulations, and when embraced by adapted public procurement criteria.

Building Support Coalitions

In order to achieve alignment in transition priorities and policies it is important to involve all government domains and layers that may contribute to achieving the headline target. The crafting and implementation of a coherent long-term strategy benefits from a 'whole of government'-approach to within-government coordination, based on principles like joined up policy making, boundary management, management of interdependencies and shared understanding.

- A suitable starting point in the Greek situation is to work towards the development and rapid adoption of national mission. A whole-of-government approach can be further strengthened by developing **shared agendas** that specify how the ambitions and support measures of different policy departments relate to each other. Such agendas would need to be centred around a clear vision on how to meet transition goals as captured by the headline targets. Obtaining insights into the growth opportunities as identified by industry can be managed by deploying the 'fora' Greece has already worked with, or by inviting firms (together with science and society) to develop roadmaps on the main opportunities and bottlenecks they see. For the Ministry of Economy and Development this would mean they do not necessarily take the lead in writing an industrial transition agenda, but they would still need to be able to organize the process of involving stakeholders and balancing their priorities.
- One promising way of uniting actors around a shared goal is to **build a support coalition**. Support coalitions consist of allying groups of stakeholders articulating their interests, exploring differences and commonalities, aligning priorities, and developing (or at least endorsing) an agenda for moving forward. For Greece there are possibilities to leverage experiences with participatory events tied to the Entrepreneurial Discovery Process (EDP). A next step would be to move beyond parties representing certain technology or business sectors, and also seek for participation of members active in for instance education or citizen movements. A suitable device for improving the general understanding of the challenges and opportunities of the transition towards RES-based transport is to shape a vision, translate it into a mission with a clear ambition level, and draw up a corresponding concrete shared agenda to which also non-directly involved stakeholders can commit.

Managing Resistance to Change

To mediate resistance due to uneven regional growth, it is important to sufficiently involve Western Macedonia in the national mission. One way to do so is by identifying transition paths that contain labour- and perhaps land-intensive production activities, such as the production of biomass.

A bolder strategy for Western Macedonia would be to consider complementary paths beyond the main RES-oriented transition. A strategy that deploys existing production strengths and skills in construction, excavation and metalworking to the massive task of restoring the environment for other uses, can pioneer globally exportable production strengths. The technologies, skills and businesses that pioneer these exportable solutions can be developed on the ground as part of *a large-scale remediation project* with a horizon of more than a decade. This can only be achieved if this major construction, land management and reclamation project is accompanied by innovation investments of progressively increasing ambition.

Obsolete industrial sites not subject to environmental remediation could be repurposed for e.g., the reuse, recycling and/or disposal of green technology waste. Productive loops can emerge. A Western Macedonian waste management industry can start off with waste from the RES-solutions in the urban and island areas, and extend this to also collecting and recycling used batteries, photovoltaics, wind turbines etc. from other countries. Moreover, Western Macedonian capabilities in environmental technologies can ensure that these activities develop in the most environmentally-responsible way. As the reclaimed resources from recycling of energy equipment (e.g. cobalt in lithium-ion batteries) constitute the building blocks of fabricating them, this pathway can pave the way for branching into manufacturing. Reversely, used green technologies imported to and recycled or remanufactured in Western Macedonia might also find their second life as part of the RES-based transition paths in Greek cities and islands.

Defining Experiments, Reforms, Policies, and Instruments

The overall objective of interventions for driving Greece's industrial transition should be to capture 'structural opportunities', emerging from nurturing development trajectories in which public and private investments (in research, human capital, infrastructures etc.) complement each other. Besides such complementarities being the key to increasing economic returns from investments, they are also essential for overcoming the inertia hampering transformation of the existing production-consumption system.

- First, there is the challenge of devising governance structures that allow for the coupling of technological and socio-economic developments that could shape a coherent transition path. This requires holistic planning based on a profound understanding of the specific possibilities resulting from Greece's set of capabilities, demands and institutions. Some of the tools that might be particularly suitable in the Greek situation are a governance working group, stakeholder round table discussions and online stakeholder engagement, an online Research, Development and Innovation (R&D&I) funding guide, and a collaboration spotting tool.
- In addition to these S3-based tools, there are also other practices that can be taken as an inspiration for setting up the coordination and acceleration activities that can drive Greece's industrial transition. One of the examples discussed prominently in this review are the Lifelong Learning Centres, which might be extended to regional field labs by combining vocational training with public-private experimentation and demonstration activities. The EU policy drive towards COVEs can be instrumental in this respect.
- Besides initiating interventions along the high-level but rather pragmatic lines sketched above, the Greek industrial transition may also benefit from a more experimental approach to exploring new solutions. It is recommended to develop small-scale and low-cost experiments that focus on for instance the major bottlenecks that keep an almost market ready solution from diffusing further. Content-wise, the most promising opportunities reside in testing solutions that might be commercialised internationally.

6.3 Workshop agendas

FINAL AGENDA
10 October 2019, Athens, Greece

Review of Industrial Transition of Greece: ***Fact-finding and stakeholder consultation meetings***
European Commission, DG Joint Research Centre

Venue: Ministry of Development and Investments (Central Building), Nikis 5-7, Syntagma, Athens
3rd floor, Room 305b

IMPORTANT: TO ACCESS THE MINISTRY PREMISES YOU MUST SHOW A VALID ID OR PASSPORT

10 October 2019

09:00 – 10:00	BUSINESS REPRESENTATIVES – GROUP I Efstratios Mpardakas, *TERNA ENERGY SA* Ilias Lamprinos, *Intracom Telecom SA* Vassilis Stamelakis, *Sunlight* Spyros Kiartzis, *Hellenic Petroleum SA* Phoebe Koundouri, *Athens University of Economics and Business* Kimon Mpotsis, *Volterra SA* Polycarpos Falaras, *NCSR Democritos*
10:00 – 11:00	GOVERNMENT REPRESENTATIVES – GROUP I (RESEARCH AND INNOVATION, PUBLIC PROCUREMENT) Konstantinos Tzanetopoulos, DG of Public Procurement, *Ministry of Development* Agni Spilioti, Asterios Chatziparadeisis and colleagues, *General Secretariat for Research and Technology* Maria Kostopoulou, Michalis Gkoumas, Smaro Zisopoulou and colleagues, *Ministry of Development and Investments* Michalis Dritsas, *Office of Vice-Minister for Development* Nikolaos Thomopoulos, *Region of Western Greece* Nikolaos Karampekios, *National Documentation Centre*
11:00	BREAK
11:15 – 12:15	GOVERNMENT REPRESENTATIVES – GROUP II (PHYSICAL INFRASTRUCTURES) Dimitris Papagiannidis, *Ministry of Infrastructure and Transport* Ioannis Tselikis, & George Ageridis, *Ministry of Environment and Energy* Athina Foka, *Ministry of Maritime and Island Policy* T. Kotzia, *Hellenic Organisation for Recycling* Nikolaos Schmidt, Local Program Coordinator, *World Bank* Angelos Amditis , Research Director, *i-Sense Group, ICCS/NTUA*
12:15 – 13:15	LEAD USERS, CONSUMERS AND CIVIL SOCIETY Andreas Apostolopoulos, President, *Electric Boat Association of Greece*

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	Aris Arvanitakis, *Phoenix Shipping Registry* George Plakotaris and Efstratios Mouflouzelis, *Region of North Aegean* Dimitris Tsekeris, *WWF Greece* Ioannis Kaldellis, Professor, *University of Western Attica* Michalis Stavropoulos, Editor in chief, Editor, *4troxoi ("4 wheels") Magazine* Alkistis Florou, Policy Officer, *Dafni Network* Elena Tavlaki, Business Development Director, *Fortisis S.A.*
13:15	LUNCH BREAK
14:00 – 15:00	CURRICULA, TRAINING, SKILLS AND URBAN MOBILITY Konstantinos Agrapidas, *Ministry of Employment and Social Affairs* Rania Economou, *Ministry of Employment and Social Affairs* Dimitrios Antonopoulos and Aikaterini Andritsaki, *Ministry of Education* Georgios Skodras, Director 6General, *Organisation for Urban Transport of Thessaloniki* Ioannis Skoumpouris, Chairman, *Athens Public Transport Organization*
15:00 – 16:00	RESEARCHERS, ANALYSTS AND SOLUTION PROVIDERS – GROUP I Pantelis Capros Professor, E3MLAB, *National Technical University of Athens* Kyriakos Panopoulos, Coordinator, *GSRT Energy Platform, CERTH* George Andreou, Assistant Professor, *Aristotle University of Thessaloniki* Nikolaos Karapanagiotis, *Centre for Renewable Energy Sources*
16:00 – 17:00	BUSINESS REPRESENTATIVES – GROUP II Xenophon Verykios, Managing Director, *HELBIO SA* George Daniolos, CEO, *Heron Thermoelectric SA* Athanassios Mpaltopoulos, *ADAMANT COMPOSITES (energy storage)* Dimitrios Vranis, DEDDIE *(Hellenic Electricity Distribution Network Operator)* Giannis Kourouklis and Sotiris Tsakanikas, *Elinverd Smart Energy Solutions*
17:00	BREAK
17:15 – 18:15	RESEARCHERS, ANALYSTS AND SOLUTION PROVIDERS – GROUP II Nikos Hatziargyriou, Professor, *NTUA* Theofilos Ioannidis, Research Director, *FORTH* Athanassios Mpallis, Associate Professor, *NTUA* Ioannis Kaplanis, Research Fellow, *Athens University of Economics and Business* Filippos Farmakis, Assistant Professor, *Democritus Univ Thrace*
18:15 – 19:00	LEADERS OF KNOWLEDGE ORGANISATIONS Evangelos Mpekiaris, Institute Director, *IMET/CERTH* Yiannis Vasileiou, Chairment *ICCS/NTUA* Georgios Nounesis, Director of Research, *NCSR Demokritos* Spyros Voutetakis, Institute Director, *CPERI/CERTH*
19:00	END

European Commission

AGENDA

18 February 2020, Athens, Greece

Review of Industrial Transition of Greece: *Fact-finding and stakeholder consultation meetings*

European Commission, DG Joint Research Centre

Venue: Ministry of Development and Investments (Central Building), Nikis 5-7, Syntagma, Athens, 3rd floor, Room 305b

IMPORTANT: TO ACCESS THE MINISTRY PREMISES YOU MUST SHOW A VALID ID OR PASSPORT

18 February 2020

09:00 – 10:30	IN-DEPTH DISCUSSIONS WITH STAKEHOLDERS PARALLEL THEMATIC SESSIONS : • SHIPPING AND PORTS (INCLUDING RECREATIONAL SHIPPING) Christos Gousias and Sotiris Gkekas, *Special Service of EU Structural Funds for the Ministry of Shipping and Island Policy* Phoebe Koundouri, *Athens University of Economics and Business* Dimitris Koukas and Angelica Kemene, *Optima Shipping Services* Dimitris Spyrou, *Piraeus Port Authority S.A.* Kostas Vlachos, *LATSCO Shipping Ltd.* George Mantalos, *StarBulk S.A.* Dimitris Tsekeris, *WWF Greece* • GOVERNANCE OF THE TRANSITION: R&D AND INNOVATION Maria Kostopoulou and Michalis Gkoumas, *Ministry of Development* Spyros Voutetakis, Institute Director, *CPERI/CERTH*
10:30-11:00	COFFEE BREAK & JRC TEAM COORDINATION
11:00-13:30	IN-DEPTH DISCUSSIONS WITH STAKEHOLDERS PARALLEL THEMATIC SESSIONS : • GOVERNANCE OF THE TRANSITION: PUBLIC-PRIVATE-PARTNERSHIPS AND PUBLIC PROCUREMENT Ioannis Kotakis and Alexandra Mexa, *General Secretariat for Industry, Ministry of Development* Konstantinos Tzanetopoulos, DG of Public Procurement, *Ministry of Development* • PRIVATE ELECTRIC VEHICLES AND CHARGING INFRASTRUCTURE Efrosyni-Eva Kotsaki and Ioannis Tselikis, *Ministry of Environment and Energy* Angelos Amditis , Research Director, *i-Sense Group, ICCS/NTUA* Christina Anagnostopoulou, *ICCS/NTUA* Athanasios Mpallis, *NTUA*
13:30-14:30	LUNCH BREAK & JRC TEAM COORDINATION

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14:30-16:00	IN-DEPTH DISCUSSIONS WITH STAKEHOLDERS PARALLEL THEMATIC SESSIONS : • INNOVATION AND VOCATIONAL SKILLS IN THE ENERGY AND TRANSPORT SECTORS Agni Spilioti, *General Secretariat for Research and Technology* Rania Economou, *Ministry of Employment and Social Affairs* • BATTERIES PRODUCTION, RE-USE AND RECYCLING Anna Kantza, *Re-Battery S.A.* Sofia Houma, *Houmas S.A.* • GRID INFRASTRUCTURE Vassilis Nikolopoulos, *PROTERGIA, Mytilineos S.A.* Dimitrios Vranis, *DEDDIE (Hellenic Electricity Distribution Network Operator)*
16:00-16:30	COFFEE BREAK & JRC TEAM COORDINATION
16:30-18:00	IN-DEPTH DISCUSSIONS WITH STAKEHOLDERS PARALLEL THEMATIC SESSIONS : • INTEGRATED SOLUTIONS FOR RES IN NON-INTERCONNECTED ISLANDS Kostas Komninos, *Dafni Network of Sustainable Islands* Ioannis Kaldellis, Professor, *University of Western Attica* Andreas Apostolopoulos, President, *Electric Boat Association of Greece* • EPUBLIC TRANSPORT Dimitris Papastergiou, *President Central Union of Municipalities of Greece, Mayor of Trikala* Georgios Skodras, *Organisation for Urban Transport of Thessaloniki*
18:00	END

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List of acronyms

AI	Artificial Intelligence
AUTH	Aristotle Univ Thessaloniki
CEF	Connecting Europe Facility
CERTH	Centre for Research and Technology Hellas
CO_2	Carbon dioxide
COTS	Commercial Off The Shelf
COVEs	Centres for Vocational Excellence
CPERI	Chemical Process Engineering Research Institute
CRES	Centre for Renewable Energy Sources and Saving
DAFNI	Network of Sustainable Greek Islands
EBA	Electric Boat Association of Greece
EDP	Entrepreneurial Discovery Process
EGD	European Green Deal
EGDIP	European Green Deal Investment Plan
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EIEAD	National Institute for Labour and Human Resources
EU	European Union
EV	Electric Vehicle
FDI	Foreign Direct Investment
FORTH	Foundation for Research and Technology Hellas
GDP	Gross Domestic Product
GDPR	General Data Protection Regulation
GENOP-DEI	General Federation of the Public Power Corporation Workers
GW	Giga Watt
GWh	Giga Watt hour
HAIPP	Hellenic Association of Independent Power Producers
HCC	Hellenic Competition Commission
HEDNO	Hellenic Electricity Distribution Network Operator-
HEI	Higher Education Institutions
HELAPCO	Hellenic Association of Photovoltaic Companies
HELLASRES	Greek Association of Renewable Energy Sources Electricity Providers
HELPE	Hellenic Petroleum S.A.
IPTO	Independent Power Transmission Operator
ESIF	European Structural and Investment Funds
HEnEx SA	Hellenic Energy Exchange S.A
HRA	Hellenic Recycling Agency
HWEA	Hellenic Wind Energy Association
ICT	Information and Communication Technology
IGME	Greek Institute of Geological and Mineral Exploration-
IPCEI	Important Projects of Common European Interest-
JRC	Joint Research Centre
KTO	Knowledge Transfer Offices
MOTS	Military Off The Shelf
Mtoe	Million Tonnes of Oil Equivalent
NCSR	National Centre for Scientific Research "Demokritos"
NECP	Greek National Energy and Climate Plan
NGO	Non-Governmental Organization
NTUA	National Technical University of Athens
NUTS2	Nomenclature of Territorial Units for Statistics, level 2
OAED	National Employment Organisation
OASA	Athens Public Transport Organisation

OECD	Organisation for Economic Cooperation and Development
PCP	Pre-Commercial Procurement
POINT	Projecting Opportunities for INdustrial Transitions
PPC	Public Power Corporation
PPI	Public Procurement of Innovation
PRO	Public Research Organisation
R&D	Research and Development
R&D&I	Research, Development and Innovation-
RAE	Regulatory Authority for Energy
RES	Renewable Energy Sources
SEF	Association of Photovoltaic Energy Producers
SME	Small- and Medium-Sized Enterprise
SWOT	Strengths, Weaknesses, Opportunities and Threats
UI	User Interface
UMIT	Understanding and Managing Industrial Transitions (JRC Working Group)
UNFCCC	United Nations Framework Convention on Climate Change-
UX	User Experience
V2G	Vehicle to Grid
VET	Vocational Education and Training
WWF	World Wide Fund for Nature

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