



OECD-IIASA Strategic Partnership on Systems Approaches

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Task Force on Systems Thinking, Anticipation and Resilience

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Report on Substantive Discussions and Proposals for Collaboration

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In December 2017, Mr Angel Gurría, Secretary General of OECD and Prof. Dr. Pavel Kabat, Director General of IIASA, signed a Memorandum of Understanding which is intended to strengthen cooperation between the two organisations so as “to tighten the links between science and analysis on the one hand with policy and action on the other to better address global challenges through the development of systems approaches.”

The Memorandum of Understanding provided for the establishment of the OECD-IIASA Task Force on Systems Thinking, Anticipation and Resilience which “shall identify and coordinate areas of work of mutual benefit.” *(For an overview of the initiative see Background Note SPTF1/18/2).* Both OECD and IIASA have designated senior expert Members for the Task Force. *(Participant Profiles SPTF1/18/8.)*

The first meeting of the joint OECD/IIASA Task Force was held at OECD on 31st January 2018. The meeting was preceded by a meeting of Permanent Representatives to OECD who were briefed on the Strategic Partnership and the aims of the Task Force. *(Briefing Note, SPTF/18/5).*

The principal purpose of the Task Force meeting was to draw on the remarkable expertise of its Members, designated by IIASA and OECD, so as to clarify the modalities of cooperation and to identify areas of mutual interest and specific activities for joint action to implement the Strategic Partnership.

This Report is structured as follows:

Part 1: Report on Substantive Discussions

1. Introductory statements.
2. The purposes of the Strategic Partnership and the role of systems thinking,
3. The approach to be adopted for collaboration between IIASA and OECD.
4. The aims of the Task Force.
5. Organisation, financing and development of the Strategic Partnership.

Part 2: Proposals for Collaboration and Joint Action

1. Systems-based strategies to address global issues
2. Improved analytical methods
3. Extending current collaboration
4. Initiating specific new topics for collaboration
5. Additional proposals by Task Force Members for joint action

PART 1: REPORT ON SUBSTANTIVE DISCUSSIONS

1. Introductory Statements

The meeting was opened by Ms. Gabriela Ramos, Chief of Staff of OECD and G20 Sherpa who underlined the potential of the Strategic Partnership to transform the way we tackle existing and emerging global challenges, to enhance the scientific basis of policy and to advance systems thinking within the OECD. She also stressed the importance of ensuring that the work of the Task Force be properly linked to related activities and interests in Member countries.

Professor Kabat then confirmed the strong commitment of IIASA to achieving the aims of the Strategic Partnership which should strengthen the science and evidence base for policy and enhance the impacts of the applied systems analysis of IIASA's highly qualified scientists. He also underlined the opportunities arising from the complementary nature of the diverse expertise, networks and influence of the two prestigious organisations in their respective fields of science and policy.

Mr. Martin Lees in his introductory remarks then outlined the structure and purposes of the Agenda and, specifically, the main aims of the Task Force at its first meeting, to propose joint activities and methods of collaboration for consideration by the leaders of the two organisations.

Under its Agenda, (*Agenda SPTF1/18/1*), the Task Force considered: the potential of the Strategic Partnership to enhance cooperation and action on global challenges; the role of systems thinking, anticipation and resilience in new approaches to policy formulation and action; joint activities and methods of collaboration between IIASA and OECD; the aims of the Task Force itself and the organisation, financing and development of the Strategic Partnership.

2. The Purposes of the Strategic Partnership and the Role of Systems Thinking.

The membership of the Task Force constitutes a unique capability of expertise, knowledge and influence across a very wide diversity of fields both in the areas of science and systems analysis and of national and international policies. In the extensive discussion of the potential of the Strategic Partnership and the role of systems thinking, there was a remarkable level of agreement among the Members which can be summarized in two points:

- there is a clear need for new ideas and approaches to provide a sound basis for better-informed decisions to manage the intensifying economic, environmental and social challenges we face;
- as these challenges are systemic, interconnected and dynamic, systems thinking, coupled with improved anticipation and strengthened resilience, provides a coherent methodology and the necessary tools to develop the new approaches which are so urgently required to formulate and implement more coherent and effective policies.

The Task Force Members achieved a consensus on the synergies and opportunities which will emerge from their multidisciplinary, cross-sectoral collaboration. They concluded that the Strategic Partnership can be of real value to the Member and Partner Countries and Institutions of the two organisations at this time of rapid global transformation and that it can achieve the purposes set out by the Secretary General of OECD and the Director General of IIASA.

3. The Approach to be adopted for Collaboration between IIASA and OECD.

The Members of the Task Force were asked to give their views on the methods of work and collaboration. It was clear that successful personal and institutional activities have been undertaken over many years through collaboration between IIASA and OECD for specific topics and events. This has created a solid base of trust and experience to strengthen cooperation in future years.

In principle, the Task Force should be seen as a catalyst to stimulate and support direct collaboration between interested parties in the two organisations. As the programme of work is clarified and the joint activities are initiated, further decisions can be made to ensure the proper exchange of information and effective collaboration.

Key points identified in the discussion were:

- (i) Systems thinking is essential to understand the world we are living in while anticipation and resilience are central to addressing global challenges. We are dealing with a world characterized by nonlinearities, tipping points and asymmetrical relations where small causes can have major consequences.
- (ii) The programme of the Strategic Partnership should itself reflect a systems approach, ensuring that the linkages, synergies and trade-offs between the selected topics are properly considered.
- (iii) There is resistance or indifference to policy advice in many areas, for example a reduced commitment to implement the SDGs and declining trust in institutions. However, due to the growing recognition that established business-as-usual approaches to policy are proving inadequate, the current situation is now conducive to greater acceptance of new ideas.
- (iv) The Strategic Partnership should aim to provoke significant paradigm shifts and institutional innovation and structural change within governments to address emerging challenges and also to overcome the rupture between scientific knowledge and community standards and values.
- (v) The purpose should be to get governments to think and act more holistically and to make policy-makers think again, showing the benefits and results from systems thinking. This implies a special effort to engage policy makers directly in analysis and new thinking and to communicate the results through careful messaging, moving beyond technocratic policy advice to use video presentations and briefing materials, scenarios and role playing techniques.
- (vi) The success of the Strategic Partnership will depend on effective linkages to Member and Partner countries and Institutions and on engaging networks of influence for wide participation and the dissemination of results.

Interested IIASA and OECD Member countries and Committees can play a key role in advancing systems thinking, anticipation and resilience in their activities, enhancing the interface between science and policy. This is particularly the case of those countries which are Members of both OECD and IIASA.

- (vii) The Task Force, through its Members, should become a mechanism for the wider dissemination of information within both organizations on relevant studies, analyses and outcomes in different sectors to widen the effectiveness of research and the impacts and understanding of systems thinking.

It was emphasized that, as all the Members of the Task Force are intensely busy, additional financial and human resources will have to be generated to ensure the success of the Strategic Partnership. Once a clear programme is agreed, it should be possible to obtain additional resources.

4. The Aims of the Task Force

The Members reviewed and agreed the “Aims of the Task Force” as set out in Section IV of the Background Note, briefly as follows:

- (i) The Task Force will **combine the expertise and experience of OECD and IIASA** in developing new systems approaches to global challenges.
- (ii) It will **identify areas of joint interest and mutual benefit** and will combine capabilities across the interface of science, systems thinking and public policy through the design and implementation of joint projects.
- (iii) The Task Force will strengthen and **extend the wide array of existing OECD/IIASA working relationships and introduce innovative joint activities.**
- (iv) The Task Force should **encourage wide interest within OECD in the role and potential of systems thinking** to achieve a better cross-fertilisation of the enormous expertise and experience available in the various OECD Directorates. In parallel, it should **stimulate greater awareness within the high-quality scientific programmes at IIASA**, of the economic and policy considerations which can enhance the impacts of their analyses and proposals.
- (v) The Task Force will **define its methods of work** including the exchange of information to assure its effective implementation. And it will, when appropriate, propose practical follow-up activities for OECD and IIASA on Systems Thinking, Anticipation and Resilience. It should aim to break up silos and establish a coherent common narrative to organise thinking.
- (vi) The Task Force will build on the existing connections of OECD and IIASA in the scientific and policy communities to **develop a worldwide network of institutions and experts** interested in collaborating in systems thinking, anticipation and resilience so as to expand the Strategic Partnership and to make the initiative visible and connected with influential stakeholders, including at the political level.

5. Organisation, Financing and Development of the Strategic Partnership.

The Memorandum of Understanding provides that the Parties may cooperate in various ways, including:

- Conducting joint symposia and workshops;
- Setting up a joint task force to identify and coordinate areas of work of mutual benefit;
- Consulting each other as deemed appropriate regarding policy dialogue;
- Joint research, projects and programmes on systems approaches and
- Exchange of staff, subject to separate written agreements on the modalities.

The MoU also makes provision for the protection of intellectual property rights and specifies that each Party will be responsible for its own activities. It is evident that additional financing and human resources will be required at the appropriate stage to implement the programme of the Strategic Partnership.

The Task Force agreed that the steps to implement the Strategic Partnership should be as follows:

The conclusions and recommendations arising from the Task Force meeting should be presented by the Chairman to both organisations in time for a meeting of the Secretary General and the Director General in Vienna in early March 2018. These recommendations were considered for approval and amended as necessary and will now be circulated to Members of the Task Force for comment. They will then be finalised by the end of March. On this basis, the planned programme of work and methods of collaboration, initial activities and financial implications will be defined and a process will be engaged to raise the necessary finance.

The development of the Strategic Partnership is envisaged in two phases over a total period of three years. During the first development phase, (*1st July – 31st December 2018*) joint activities will be defined and initiated to demonstrate the feasibility and benefits of collaboration. On this basis, resources should be found for the second phase, (*1st January 2019 – 30th June 2021*) and a suitable organisational framework put in place to expand the activities of the Strategic Partnership within the two organisations so as to produce influential results within the first three years.

Building on IIASA's international network of partners at the highest level of science and on OECD's unique links to experts, policy makers and leaders across the world, it will become possible to strengthen the Strategic Partnership and the impacts of its results by engaging with a worldwide network of partner institutions and with civil society.

In the closing discussions, the Task Force Members agreed that, by combining their scientific, economic, social, environmental, institutional and policy expertise, it will be possible to define together innovative proposals for strategies and measures to face the critical challenges which threaten the future of humanity.

The Strategic Partnership between OECD and IIASA can thus help Member and Partner States and Institutions and other actors and citizens to understand the complexity of the issues we face and to manage rising levels of risk and vulnerability under conditions of uncertainty. It can provide an international focus and intellectual leadership for the evolution of the new ideas and approaches so urgently required to improve the prospects for inclusive, stable and sustainable progress and peace.

PART 2: PROPOSALS FOR COLLABORATION AND JOINT ACTION

1. Issues and Joint Activities considered at the Task Force Meeting

The work programmes of OECD and IIASA include an enormous range and diversity of activities. It was a prime purpose for the first Task Force meeting therefore to suggest a limited number of collaborative activities which will be manageable and likely to show valuable results in a reasonable time. Although the time available to identify potential joint activities was very short during the one-day meeting, an intense and rich discussion generated many ideas and proposals for collaboration.

This wide diversity of proposals could be structured and presented in many different ways. They are organized here around five major themes which were of wide interest during the discussions, so as to move towards agreement on a coherent programme of work under the Strategic Partnership. These themes also provided the basis for the recommendations by the Chairman submitted to the leaders of IIASA and OECD for consideration at their meeting on 5th March.

The chosen themes are consistent with the Memorandum of Understanding which provides that "collaboration between the Parties will focus on a number of substantive areas, including but not limited to:

- (i) Developing approaches to economic challenges to enhance understanding of the complexity of the global economy, society and environment;
- (ii) A systems approach to the analysis of economic performance and exploration of how far systems thinking could be taken in understanding the evolution of a national economy;
- (iii) Analysis of risk and resilience and the recognition of uncertainty in the management of complexity;
- (iv) International cooperation in science, technology and innovation to advance knowledge and address grand challenges;
- (v) Investigation of connections between climate, energy and international finance."

Drawing on extensive consultations at OECD and IIASA, the Background Note for the meeting proposed a preliminary framework to organize the joint activities to be suggested by the Members of the Task Force. After discussion, it was agreed unanimously by the Task Force that the proposed framework was acceptable and that the projects could be organised in four major categories, Sections I-IV below. It was further agreed that more considered, written proposals for joint projects would be provided by the Members. Those received to date are summarized in Section V.

- I. Systems-based strategies to address global issues
- II. Improved analytical methods
- III. Extending current collaboration
- IV. Initiating specific new topics for collaboration
- V. Additional proposals by Task Force Members for joint action

I. SYSTEMS-BASED STRATEGIES TO ADDRESS GLOBAL ISSUES

The capabilities of OECD and IIASA can be mobilized through the Strategic Partnership to develop integrated strategies and better policies to address critical and connected global issues, based on a defined systems approach which recognizes the vital importance of the linkages between them, the distribution of costs and benefits over time and rising levels of risk and uncertainty. This presentation of the Task Force discussions on Systems-based Strategies is organized around five themes:

1. Economic transformation to contain anthropogenic environmental impacts.
2. Longer-term strategies for employment
3. The links of technological innovation to economic progress and the UN SDGs.
4. Strategies and governance to manage systemic risk
5. The availability and quality of water

1. Economic transformation to contain anthropogenic environmental impacts.

Global environmental challenges are starting to impinge on the world economy. The disjunction between continuing business-as-usual economic growth based on rising levels of consumption, resource exploitation, pollution and waste and tightening environmental, energy and resource constraints was repeatedly identified as an area of common concern. The OECD Council has recognized that growth is not an end in itself but a means to the broader goals of human wellbeing, a safe environment and a stable and productive society. (This accords with item (i) of the MoU mentioned above, “Developing approaches to economic challenges to enhance understanding of the complexity of the global economy, society and environment.”)

The economic, social, human and security implications of intensifying climate change, air and water pollution, resource scarcity and ecological degradation and biodiversity loss present another crucial set of related issues which will significantly influence the growth and stability of the world economy and the prospects for humanity. Systems thinking will be essential to the new approaches needed to understand and manage such existential global challenges. For example, an understanding of the synergies and dynamics of the complex systems which drive the climate is essential to assess the risks of crossing thresholds to irreversible climate change.

The following key points were made:

- Economic activity is approaching planetary boundaries. The Strategic Partnership can combine scientific and policy expertise to promote a paradigm shift towards economic transformation for sustainable development, away from deepening a business as usual, GDP focused trajectory.
- A more coherent, systemic approach to critical global issues is needed, taking proper account of the real linkages between the economic, social and environmental facets of policy and action and their implications for risk and resilience. The Strategic Partnership can take a lead in this effort.
- It is urgent to take proper account of environmental feedbacks on economic growth and to incorporate more effectively policy responses to ecological, environmental and climatic impacts in economic planning.

- Fundamental structural changes will be required in economies, energy and other infrastructures and lifestyles to achieve a stable climate, a viable environment and a sustainable balance between human needs and the boundaries of natural systems. These changes will have major implications for investment strategies and for the world financial system, for example, the increasing significance of stranded assets and the carbon budget. (In line with MoU item (v): “Investigation of connections between climate, energy, water and finance.”)
- A joint, multi-year project could be undertaken by IIASA and OECD to develop integrated, cross-sectoral strategies and tools and models of transformative change to address this complex of global issues. (See *Part 2, Section V below*)

A number of Members underlined the economic and human consequences of climate change and air pollution and emphasized the central importance of the economic, environmental, ecological and climate nexus and the need for innovative policies based on shared and integrated pathways for resource efficiency, climate change and air pollution.

Recognising the intensifying threats of ecological and environmental degradation and climate change, a specific focus was suggested: Where are the thresholds to non-linear change and how can we develop approaches to better quantify such thresholds?

2. Longer-term strategies for employment

The Task Force considered the onslaught of disruptive technologies, such as Digitilisation, Artificial Intelligence and Robotics, which raises profound issues of the availability and nature of employment in both industrialized and developing countries. The issue was raised of the implications of changing age structures, demographic change and education for labour force participation and future economic prospects.

An integrated systems approach is essential for modeling and analyzing employment issues which involve essential linkages to a wide range of other facets of policy.

IIASA has solidly-based, analytical and modeling capabilities in the fields of demographic change and human capital which are fundamental to understanding the essential connections of employment, poverty and hunger and more generally, of world development, including soils, water, energy and food security and world health and migration.

3. The links of technological innovation to economic progress and the SDGs.

Rapid technological change can generate major economic and social challenges and also offer enormous opportunities. The DSTI at OECD has been working on issues of science policy, research, development and innovation since the Sixties. (In accord with item (iv) of the MoU: “International cooperation in science, technology and innovation to advance knowledge and address grand challenges”)

Some key points raised in the discussions were:

- The speed of technological change through the introduction of disruptive technologies, such as digitisation, robotics, biotechnology, artificial intelligence and driverless transport, coupled with sharing and lifestyle changes, is beginning to generate deep transformations in economies and societies with major consequences for consumption, production and employment.
- Technological innovation will be essential to achieving the SDGs, for example, targets to maintain the rise in global average temperature below 1.5 or 2°C will be unattainable without massive diffusion of suitable technologies, such as CCS - Carbon Capture and Sequestration.
- The role of governance in facilitating the orientation of research, development, innovation and investment to priority human goals will be crucial to offset the 2nd order effects of technological change.

4. Strategies and governance to manage systemic risk

Issues of systemic risk, uncertainty and resilience were important themes throughout the meeting, in which both OECD and IIASA experts found much common ground. (This again accords with the MoU, item (iii): “Analysis of risk and resilience and the recognition of uncertainty in the management of complexity.”)

The following key points were raised:

- There has been a failure of collective imagination to recognize and anticipate the potential consequences of synergies and cross-cutting systemic risk. Chaos theory shows that small impacts can have large effects and the failure to manage complexity can lead to the spread of contagion, triggering cascading failures.
- The governance of systemic risk implies collective responsibilities, including to avert “the tragedy of the commons” which can lead to catastrophic public costs.
- Techniques must be further developed to manage financial risk and to organize ourselves to anticipate and to build robustness and resilience to major shocks.
- These shocks can trigger repercussions which extend far beyond the economic and environmental spheres, with adverse consequences for social cohesion, political stability, human and national security and governance. As we have seen, economic recession can give rise to populism and social crisis.
- In the modern world, decision makers are confronted by the need to understand interconnectedness and complexity, which may have stabilizing or destabilizing effects. They must manage risk under conditions of uncertainty which implies looking beyond mean values. Systems thinking is fundamental to understanding the implications of uncertainty and also to the analysis and management of systemic risk.

5. The availability and quality of water

Experts from both OECD and IIASA participated in a discussion on the strategic significance of water in general and groundwater in particular in the perspective of international trade, all fields in which the two organizations together have remarkable expertise: (See also Section V.5 below.)

- Countries are increasingly connected by the international food trade and the groundwater, food and trade nexus is increasing in strategic importance. For example, the US is effectively exporting and China is importing non-renewable groundwater through the food trade.
- There is a crucial gap between demand and supply of water in Africa which requires urgent attention as populations increase and climate change intensifies.
- The availability and recycling of water are becoming increasingly important to the functioning and sustainability of cities, with major second order consequences.
- Analysis and action on water issues requires the integration of the social and natural sciences to take account of all the relevant facets of policy, ranging from human needs and behavior, poverty, hunger and food security to supply chains, the food web, technology choice, investment and the concentration of market power.

II. IMPROVED ANALYTICAL METHODS

The Strategic Partnership can contribute to the evolution of new approaches to critical global challenges - including methodologies and paradigms for economic growth and equitable and sustainable development adapted to meet the new conditions of the 21st Century. (In accord with the MoU, item (ii): A systems approach to the analysis of economic performance and exploration of how far systems thinking could be taken in understanding the evolution of a national economy);

There is intense debate within and around the economic community as to how concepts, models and methodologies can adapt to meet new perceptions and concerns, for example: to recognize the realities of the natural world; to contain rising levels of systemic risk; and to take better account of human aspirations and behavior and of inequality and exclusion, now linked to the rise of populism.

It was clear from many contributions in the discussions that there is a strong common interest and potential for the development of innovative modeling technologies and tools. Key points in the discussion were:

- The systems approach can contribute to improved formulation of economic analysis and can contribute to a different framing of complex issues. It offers a rigorous framework and tools to understand and act on connected and dynamic issues.
- A central challenge is how to bring big issues together - in a reductionist world defined by disciplines, sectors and special interests - so as to implement new approaches to sustainable development.

Many ideas were mentioned for new approaches in modeling:

- to take proper account of non-linearity, risk and uncertainty in models.
- to improve the granularity of models at the sub-national, regional and city levels to account for local bottlenecks and differential impacts on groups.
- To develop disaggregated models to account for processes at the agent level, recognizing the self interest of actors and their wider non-economic motivations.

- to develop new tools to bring together analysis at the national and sub-national levels.
- To develop new methodologies to include behavioral responses in models, recognizing realistic human behavior.
- To integrate real-world evidence into models so as to combine modeling and empirical work, for example to evaluate consumer behavior.
- To include incentives and disincentives to address social dilemmas.
- To embed experimentation in the policy framework and to marry qualitative research relying on stakeholder deliberation with quantitative methods.

The depth of expertise in modeling at IIASA and OECD, coupled with deep knowledge of science and policy, will ensure that joint projects in the field of modeling will produce significant results in terms of improved paradigms, data and insights to strengthen the foundations of policy. It was however pointed out that it is difficult to raise funds for model development.

III. EXTENDING CURRENT COLLABORATION

A wide array of working relationships have been established between OECD and IIASA over many years and discussions were initiated at the Task Force meeting to deepen and extend them.

Areas of current collaboration are principally:

- **Advanced Systems Analysis.** Collaboration has been on-going on a number of themes such as: decision support tools; resilience; optimal allocation of land for agri-food and energy production; and preparing resilient strategic plans under high risk and uncertainty. A possible project is under consideration on Eurasia Economic Integration.
- **Risk and Resilience.** Collaboration on a project on “Systems Thinking for Transformation”; IIASA has participated in the 7th OECD High-level Risk Forum; In 2017, IIASA ran a session of the “World’s Future Game” at OECD, focused on the trade-offs between the SDGs.
- **Water: Co-hosting events and collaboration on “Opportunities and Limits to Water Pollution Regulations”, and water governance and water quality.** There are common interests and potentials for deepened cooperation on water issues, particularly with the OECD Environment Directorate in the context of financing investments in water at scale, which are of high interest to both organizations.
- There is also cooperation from time to time in the fields of energy and climate for specific issues and events, which could be expanded to support country-level engagement on low-emissions pathways
- The Environment Directorate is actively engaged with IIASA on modeling for a number of years and sees opportunities to further deepen this collaboration.

IV: SPECIFIC NEW TOPICS FOR COLLABORATION

During the Task Force meeting, Members were able to suggest a wide range of issues which could become the focus of specific joint projects. Some of these will be developed through bilateral cooperation. Ideas suggested were:

- The possibility of collaboration on National Reviews, or on reviews at the regional level, aiming for national studies enriched by ecological, energy and health dimensions and consistent with Agenda 2030 and the UN SDGs.
- Build a policy matrix around the economic, social and environmental facets of policy linked to wellbeing, and relate this to policy alignment across government systems to clarify choices, synergies and trade-offs.
- Analyse economic and financial interactions with the social fabric, with deeper analysis of practical issues such as housing and ageing linked to social and environmental factors and living standards.
- Analyse the greening of the transportation sector, linking transport, energy demand and innovation.
- Undertake a whole systems study of air pollution, including behavior, e.g. of car manufacturers, and the socio-economic consequences.
- Map out the systemic issues related to nitrogen management.
- Undertake a study of resource exploitation policies, including the interests and behavior of corporations.
- Develop proposals to improve financial resilience to shocks due to natural hazards.
- Linking IIASA modelling capabilities in areas such as energy and water to OECD policy and finance expertise.
- Undertake a project on the modeling of innovation systems.
- Explain the systems thinking paradigm to decision makers and officials.

V. ADDITIONAL PROPOSALS FOR JOINT ACTION

Following the Task Force meeting, many Members have already provided more developed project proposals which are sketched below.

1. OECD: Directorate for Science Technology and Innovation

- (i) Modeling global supply and demand for sustainable biomass for the bio-circular economy.

Sustainability of global biomass is critical to meeting several of the UN SDGs. Biomass is an important part of food and energy systems and of material use in production systems. In order to support the transition to a bio-circular economy, robust projections and scenarios of biomass supply and demand at the global level are needed. The OECD's strength in statistical, empirical data and its close links to the IEA could complement IIASA's strengths in modeling and scenario building and behavioral analysis. The output would be a sophisticated model for biomass supply and demand to 2060.

- (ii) Integrating systems design in the development of the OECD's STI policy database.

The empirical evidence used in the framework which underpins STI policies remains characterized by linear thinking. Data do not sufficiently allow policy makers to assess where, what and how much they should direct public policy support to science, technology or innovation. To address this shortcoming, the OECD will soon deploy a new semantic database of national STI policies. Collaboration between IIASA and OECD could improve this new database and user tools which will structure policy information to enable systems-based policy analysis.

- (iii) Meetings and workshops on tools and methodologies for integrating system modeling in innovation policy analysis.

One recommendation emerging from a 2015 NAEC Report was that OECD should analyse the world economy as a “complex adaptive system” taking account of uncertainty, spill-overs and network effects, and that this would require the development of new tools and instruments and to systematize their use across the Organisation. The objective of the collaboration would be to foster dialogue between OECD innovation policy analysts and IIASA's systems analysis experts on the usefulness of new tools and methodologies such as agent-based modeling, simulation and behavioral modeling, for science and innovation policies. A series of workshops would foster dialogue, training and capacity building.

2. IIASA: Advanced Systems Analysis (ASA) Program

- (i) Decision-making under uncertainty to quantify the food-water-energy nexus

Economic activity in many regions of the world is approaching planetary boundaries. Planning of critical sectors can no longer be done in isolation. Forward-looking models are used to anticipate the future development trajectories of agriculture and energy, but uncertainty is rarely included. The ASA program has developed methods to incorporate probabilistic representation of uncertainties into models supporting decisions. This approach could be introduced into OECD models. Also, new collaborative studies could be initiated on regions of interest to OECD and IIASA, where the food-water- energy nexus is crucial for development.

- (ii) Using agent-based modeling to stimulate national and regional economies, to explore systemic risks and study resilience to external shocks.

ASA has developed an ABM framework which can simulate an entire national/regional economy with physical individuals and legal entities interacting at the micro-level. This can be used to test various policies, such as taxation policies and resilience to external shocks.

The framework is to be calibrated for the EU with each Member state as a separate module. The ABM can also be calibrated for other countries. Financial systemic risk and fiscal policies can be tested, which may be of interest to OECD.

- (iii) Futures of economic cooperation in the Greater Eurasian space and the interplay between different integration processes in the region.

The project so far has operated as a discussion platform with the aim to analyse the potential and conditions for the creation of a common economic space between the EU and the Eurasian Economic Union. OECD experts could attend workshops on these issues and joint fast track studies could clarify key issues.

3. OECD: Regional Development Policy Division: Centre for Entrepreneurship, SME's, Regions and Cities

Potential areas of interest are:

- the modeling of policy interactions to take account of non-linearities associated with policy packages;
- The introduction of granularity into analysis: there are many interesting approaches on scaling phenomena where cooperation between economists and natural scientists through the creation of multidisciplinary teams would be most productive.
- The use of machine-learning tools to address complexity. Here, few OECD staff have data-scientist competencies, whereas IIASA has comparative advantages in this respect.

Suggested topics for research:

- (i) Spatial factors of national productivity: how different regions and cities contribute to national productivity performance.
- (ii) The links between urbanization and development.
- (iii) The governance of water systems: how governance interacts with the resilience and risk management of water systems.
- (iv) The impacts of demographic trends at the regional level: regions will be affected asymmetrically by ageing – a huge policy challenge and a source of geographic fractures within countries.

4. IIASA: Transitions to New Technologies Program and Energy Program OECD: Environment Directorate

Partnership on “Mobility for the Energy Transition”

Mobility, both for people and for goods, lies at the heart of the technological, economic and social transformative changes which will arise over the coming decades. A better understanding of impacts and enabling conditions is crucial to inform sound policy and, to this end, scenario exercises underpinned by rigorous modelling analyses can play a vital role. Both IIASA and OECD have a long history of high-impact scenario modelling experience. The main objective of the work will be to identify efficient, safe, affordable and equitable pathways for passenger and freight movement in both industrialised and emerging economies which also bring significant benefits for the environment and society.

More specific questions to explore are:

- The influence of consumer preferences and behaviour on the adoption of novel transport technologies and paradigms;
- The interplay between physical infrastructure investments and new business models and the effects on consumer willingness to alter mobility patterns.
- The implications of new urban mobility patterns on urban energy systems and the potential for higher grid integration of variable renewable energy sources.
- The impacts of actions and developments in the transport sector on other parts of the economy and vice versa.
- The evolution of consumer preferences over time, especially with regard to demand for transport services in the context of overall consumer demand and the evolution of disposable income.

5. IIASA: Water Program

- (i) A continental-scale hydro-economic model for integrating water-energy-land nexus solutions

The IIASA Water Program is leading the development of a unique and innovative bottom-up, large-scale hydro-economic model, (ECHO), that works at a sub-basin scale over a continent. It has been applied as a case study for Africa. It offers the capability to integrate a detailed representation of local hydrological and technological constraints with regional and global policies and to account for the feedbacks between water, energy and the agricultural sectors. It can address challenging research questions such as examining the sustainability of water supply and the impacts of water management on the energy and food sectors and vice versa. A related short term project focuses on investment needs and financing capacities across the EU for the water sector. A longer term project focuses on financing investment in water infrastructure together with the Netherlands and WWF.

- (ii) Groundwater depletion embedded in the international food trade.

Recent hydrological modelling and Earth observations have located and quantified alarming rates of groundwater depletion worldwide, primarily due to water withdrawals for irrigation, but the connections to global food production have not yet been explored.

IIASA has established that around 11% of non-renewable groundwater use is embedded in the international food trade. The results of a joint programme could help to improve the sustainability of global food production and groundwater resource management by identifying priority regions and agricultural products at risk, as well as the end-consumers of these products. The IIASA Water Program has a long history and world leading expertise to quantify groundwater sustainability which can complement existing food, water, trade and environmental assessments at OECD.

6. OECD: Environment Directorate (Climate, Biodiversity and Water Division)

The Division works on critical climate and natural resource issues, including water, biodiversity, land-use and ecosystems and cross-cutting issues such as the impacts of nitrogen. It also is a central player in the OECD's cross-Directorate Centre on Green Finance and Investment. Increasingly it is working on developing guidance that could support countries in their aspirations to move to low-emission, climate-resilient pathways, their financing needs and the policies and enabling environment required to mobilise private investment in green infrastructures.

Collaboration with IIASA could include:

- Research on sustainable policies and pathways for financing water infrastructure at scale, taking account of economic, demographic and climatic uncertainties and country or watershed characteristics;
- Engagement with pilot countries on their strategies and policies for achieving low-emissions, climate-resilient development pathways, going beyond the energy sector. This could build on modelling expertise at IIASA and policy and modelling work at the OECD and benefit significantly from IIASA's scenario tools to elicit stakeholder preferences.

7. OECD: Environment Directorate

(potentially also OECD ECO and TAD and IIASA Ecosystem Services, Energy, Air Quality and Transitions to new Technologies)

Over the coming decades, policy agendas will be highly influenced by significant changes in socio-economic trends and their relation to the environment as well as by shifts in the relative size of major economic regions and associated trade patterns. Such changes are increasing in pace and scale and they are essentially interconnected. An integrated approach to study simultaneously policies that address resource efficiency, air pollution and climate change would be enabled by the consistent modelling of economic trends and their links to materials use and emissions in the IIASA and OECD modelling frameworks, as well as the climate and air pollution damages in the OECD CIRCLE Project.

The purpose of the proposal is to combine the modelling tools of OECD and IIASA to allow for the consistent analysis of integrated pathways for simultaneously addressing the challenges of climate change, air pollution and resource efficiency. Variations in policy packages to address environmental challenges can lead to significant differences in impacts across sectors and regions. The project will therefore study which sectors and regions have most to gain from policies and which may be adversely affected. IIASA and OECD are uniquely placed to address such issues, bringing together complementary capabilities and tools to address a large set of policy issues within a multi-modal framework sufficiently flexible to assess the specific challenges and circumstances that different world regions face.

Such a coherent framework could also serve to provide guidance to countries wishing to develop strategies to achieve the goals of the Paris agreement on climate change, to make the transition to a resource efficient, circular economy and to attain the SDG's.

8. IIASA: Risk and Resilience Program

Topics for potential collaboration with OECD include:

- Risk analysis and modelling, including flood risk assessment in Europe and systemic risk assessment for cascading losses;
- Risk policy, covering: financial instruments; fiscal vulnerability/EU Solidarity Fund; Loss and damage mechanisms.
- Governance in transition: transition to renewable energy; expert and stakeholder engagement; games; and systemic risk governance.
- Activities focused on the mitigation of systemic risk aim to develop strategies to reduce disproportionate impacts from small triggers and to avert cascading failures which threaten financial systems, ecosystems, health systems, utility grids and supply chains etc.
- Another research focus is incentive design to address social dilemmas. Many common goods are threatened by selfish actors, yet humans are not just utility maximisers. Incentive design can help to stabilise cooperative solutions.

9. OECD Public Governance Directorate : High Level Risk Forum (HLRF)

In light of the OECD's and IIASA's complementary expertise and cutting-edge research on critical infrastructure resilience and systemic risks, cooperation in this domain would provide valuable insights.

Reliable provision of critical infrastructure is essential for the delivery of socio-economic activities. The interconnectedness of critical infrastructure and supply chains exposes critical infrastructure to systemic risk, which may be triggered by cascading failures spreading across critical nodes. These increasingly interdependent systems require policy actions to ensure system resilience in a dynamic and evolving risk landscape; marked by technological progress, climate change, and the emergence of hybrid threats.

The OECD High Level Risk Forum (HLRF) work stream on the governance of critical infrastructure resilience fosters expert discussions on good practices for strengthening the security and resilience of critical infrastructure systems. The OECD promotes the use of system-thinking in policy making for critical system resilience (all-hazards and threats, multisectoral approach and interdependencies, infrastructure life-cycle, risk management cycle). The HLRF is preparing comparative analysis of country practices for boosting critical infrastructure resilience, to be presented at an expert meeting on Critical Infrastructure Security and Resilience at the OECD in September 2018.

A first opportunity for cooperation arises with the upcoming OECD expert meeting on Critical Infrastructure Security and Resilience, which will focus on interdependency mapping of critical infrastructure networks, making the case for reinforcing policy efforts for critical infrastructure system resilience. Cooperation in a case study on systemic risk in critical infrastructure networks could underpin the expert discussions during this meeting.

The joint development of an innovative model for assessing costs and benefits of mitigation measures for systemic risk in interdependent critical infrastructure networks provides a second opportunity for collaboration between IIASA and the OECD.

10. OECD Governance Directorate: Observatory of Public Sector Innovation

Over the past years, a number of Directorates have been using systems approaches but these, with the connected tools, have not permeated into the wider organisation.

The Task Force, with NAEC, can help to bring systems thinking to the forefront in the organisation. And it can serve to ensure wider diffusion by discussion of the content and methods of diverse projects based on the systems approach in different fields.

OPSI is focused on “how” systems thinking can be implemented, to build up work flows, skills, tools and organisation to support decision making by conducting research, building communities and addressing concrete, complex problems. This can be seen from a recent report on “Systems Approaches for Public Sector Challenges” and an experimental advisory programme on “Unlocking Systems Change in the Public Sector.” OPSI is now engaged on an “anticipatory government” model to explore how governments can build up reactivity and pro-activity in response to transformative technologies, specifically, how systems that can cope with deep uncertainty can be built up in the public sector for best policy outcomes.

Collaboration with IIASA could include:

- Joint research and empirical experimentation on policy support tools for systems thinking.
- Including expertise from IIASA in concrete advisory projects of OPSI and partnering with IIASA in their country-focused work, where issues are of mutual interest.
- Joint research on the “anticipatory government” model.
- Input into training modules for policy makers on innovation. Systems approaches will be included in a training module OPSI is currently developing for the public sector on public sector innovation.

11. IIASA: Ecosystem Services and Management Program

Joint OECD-IIASA Scenathons: towards coordinated multi-country development pathways.

Both the OECD and IIASA work with numerous countries to produce quantitative evidence for better policy-making. But this work is typically arranged on a country by country basis rather than in a consortium approach to elaborate joint regional or even global solutions. Through interactive scenario-planning exercises, called Scenathons, the aim is to develop a common understanding of how national development aspirations can be realised while also meeting global level objectives such as the SDG's.

It is proposed jointly to organise Scenathons, together with our Member countries, where domain experts, analysts and others involved can collaborate intensively in an iterative manner on modelling development pathways. This would build common understanding and dialogue on joint solutions to meet national and international targets.

12. IIASA Evolution and Ecology Program

IIASA's Evolution and Ecology Program (EEP) analyzes and forecasts how anthropogenic impacts affect ecological and evolutionary dynamics, thus shaping ecosystems, as well as behavioral dynamics and adaptations which shape social systems.

A multidisciplinary team, focused on the systems analysis of living systems could collaborate on systemic risk assessment, ecosystem management and human behaviour. Another focus is policies for resource exploitation, where integrative quantitative assessments can strengthen policy designs for the sustainable exploitation of living resources required for food security and economic growth. Research is also focused on incentive design to address social dilemmas. Many common goods are threatened by selfish actors, yet humans are not just utility maximisers. Incentive design can help to stabilise cooperative solutions.

Specific areas for collaboration could be:

(i) **Complexity science and new paradigms in economic theory**

The EEP could contribute to the OECD initiative New Approaches to Economic Challenges by co-developing conceptually innovative approaches to economic theory through complexity science, network theory, and game theory. The recognition that economic and socio-political processes are part of complex adaptive systems draws attention to a wide array of challenges – nonlinear feedbacks, non-equilibrium dynamics, tipping points, regime shifts, collective phenomena, emergent properties, systemic risks, resilience, deterministic chaos, deep uncertainty, social dilemmas, internalized externalities, inequalities, intrinsic values, functional diversity, and interactions across sectors and scales.

Considering the extent of this remit and the resultant need for conceptual structuring, the series of workshops proposed by the OECD Directorate for Science Technology and Innovation could be an excellent way for OECD and IIASA to start discussing and addressing these challenges. This could be complemented by joint research on co-designing and exploring selected new models.

(ii) **Bounded rationality, plural rationality, and realistic human behavior**

Understanding human behaviors beyond *homo economicus* assumptions is critical for predicting consumption patterns, risk perceptions, behavioral responses to policies, and determinants of human well-being and citizen satisfaction. This requires accounting for cognitive limitations and biases, for heterogeneous personalities, values, and beliefs, as well as for contagion and trends in the dynamics of public opinion. The EEP could collaborate in devising and testing such predictions through the use of innovative statistical and dynamical models inspired by behavioral economics, evolutionary psychology, game theory, choice theory, and cultural theory.

(iii) Systemic risks

In an increasingly interconnected world, systemic risks, cascading failures, and domino effects must be detected and mitigated. This requires understanding the dynamics of network connections and how they are influenced by regulations and incentives. The resultant insights apply across applications as diverse as supply chains, trade flows, utility grids, transportation networks, disease transmission, ecological food webs, and opinion networks, determining the capacity of these systems to absorb, recover from, and adapt to a wide range of shocks and challenges. The EEP has developed together with other IIASA programs new approaches to measuring, modeling, and mitigating systemic risks. These approaches could be bridged to OECD models, and collaborative studies could be initiated on selected applications.

(iv) Ecosystem responses to anthropogenic environmental change

Reconciling economic growth with planetary boundaries necessitates understanding how the world's biosphere is responding to anthropogenic impacts. Examples include the roles that microorganisms, vegetation, and biodiversity play in determining greenhouse-gas absorption, food security, and ecosystem stability. The EEP is working with a diverse suite of models for describing such linkages and could collaborate on corresponding integrative quantitative assessments in support of policies aiming at transformative change.

(v) Institutional design and emergence

There is a growing recognition that market players will not “self-organize into a socially desirable state” (Ramos 2017). Multilateral cooperative solutions thus require governance institutions to provide adequate incentives and regulations. Realizing that the top-down design of such institutions undermines buy-in and is often not feasible highlights the importance of an enabling culture promoting their bottom-up emergence and design through expanding agreements. Using modern game theory, the EEP is modeling such institutional dynamics. Joint activities with OECD could focus on adapting these models to case studies, e.g., by focusing on particular international agreements and governance solutions.

(vi) Training in systems thinking

The current state of world affairs is promoting a revival of systems thinking. Recognizing that the tightening of socio-economic links heightens the need for holistic responses, that disciplinary and sectoral solutions are of limited effectiveness and efficiency, and that big data is not generating integrative perspectives by itself, highlights the need for students, practitioners, and policy makers to become thoroughly familiar with the promises and pitfalls of systems analysis. Pooling the experiences of OECD and IIASA could create an ideal platform for designing training modules and decision-support tools tailored to a diverse range of audiences.

The first meeting of the Task Force, although only for one day, generated a rich diversity of ideas and proposals as outlined above. These will be consolidated and further developed.