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Good Practices and Policy Options for Accelerating the Adoption of Innovations Critical for Sustainable Development**

Note by the secretariat

I. Introduction

1. The present note presents good practices and policy recommendations on accelerating the adoption of innovations critical for sustainable development. It is based on the presentations and discussions at the substantive segment of the eighth session of the Team of Specialists on Innovation and Competitiveness Policies (TOS-ICP), held in Geneva on 16 and 17 December 2015.[1] It reflects and benefits from the experiences of all relevant participating stakeholder groups, including national government agencies, academic institutions, the business sector and international organisations.

2. The good practices and policy recommendations for addressing gaps in the adoption of innovations are relevant for countries and regions facing a variety of development challenges. The conclusions may also serve as a contribution to the implementation of the 2030 Sustainable Development Agenda at the regional level.

3. Following this introduction, the second section briefly outlines the role of innovation and innovation policy in achieving the UN 2030 Agenda for Sustainable Development. The third section introduces the problem of innovation adoption gaps. The fourth section discusses possible causes of such gaps. The fifth section discusses policy options for

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** The document is submitted on the above date due to the need to incorporate into the document recent new insights on the advantages and disadvantages of some of the policies discussed in the document.

[1] The presentations can be found at http://www.unece.org/index.php?id=40738#/.

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addressing these causes and closing innovation adoption gaps. The sixth and final section presents some general good practices and principles for the design of policies in this area.

II. Innovation and the 2030 Sustainable Development Agenda

4. In September 2015, the General Assembly of the United Nations adopted the 2030 Sustainable Development Agenda to promote inclusive and sustainable economic development. Innovation can make an important contribution towards advancing this agenda, as it drives productivity growth, conserves scarce resources and enables sustainable production and consumption patterns.

5. This is recognized in Sustainable Development Goal 9, which calls for promoting innovation. It is also recognized in Goal 11 on sustainable urban development,[2] and in the targets specified for Goal 8, including

(a) Target 8.2 "Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including through a focus on high value-added and labour-intensive sectors."

(b) Target 8.3 "Promote development-oriented policies that support productive activities, decent job creation, entrepreneurship, creativity and innovation (…)"

6 Moreover, innovation is recognized as one of the means of implementation for the entire 2030 Agenda.

III. Innovation adoption gaps

7. To fully realize the potential of innovation for sustainable development, it is necessary to encourage rapid and broad-based adoption and diffusion of innovations in fields critical for sustainable development. Cases in point include energy efficiency in buildings and transport, the move towards renewable energy, sustainable cities and the move to the circular economy, to name but a few.

8. However, there is growing evidence that aggregate performance is often far from what would be possible based on the use of current state-of-the-art technology, because the latest technologies are adopted only by a minority of firms and households. Significant progress in terms of productivity and sustainability could often be made if the latest technologies were adopted more widely and more quickly. This is especially the case in areas critical for sustainable development, including the mitigation of climate change.

9. Of equal importance is the fact that the direction and pace of innovation efforts will depend critically on the prospects of innovations being adopted rapidly and broadly. If innovative companies see no prospect of innovations in areas critical for sustainable development being adopted at scale and within reasonable time frames, they will turn their attention and resources to other areas of innovation.

10. Without policy interventions which actively steer innovation efforts into areas critical for sustainable development, progress may not occur because innovation in sustainable technologies and products may not advance more rapidly than innovation in conventional technologies and products.[3]

[2] Transforming our world: the 2030 Agenda for Sustainable Development, para. 34.

[3] For instance, the historical record shows that the pace of innovation in exploration and drilling techniques has been rapid enough to keep increasing the level of proven fossil fuel reserves relative to

11. There is therefore a growing interest in understanding the causes of such gaps and in policies that may reduce them.

12. At the same time, there may be valid reasons not to adopt certain innovations more rapidly, depending on specific local circumstances and national policy contexts.

13. For instance, the total impact on greenhouse gas emissions from a wider adoption of electrical or hybrid-electrical vehicles depends among other things on how the electricity used to power these vehicles would be generated. Depending on the power mix of the installed electricity generation capacity, traditional fuel-powered vehicles may generate a lower or higher total level of emissions than innovative electrical or hybrid engines. The total balance also depends on other factors such as individual mobility patterns.

14. Another factor to be taken into account is the total impact on sustainability over the entire useful life of a product, including production, usage and scrapping or recycling. Whether the welfare of society is improved by more rapid adoption, e.g., of innovative consumer products may thus depend on usage patterns, on the rate at which technological progress improves sustainability-relevant features of these products (such as their energy efficiency), and on the impact on sustainability of their production.

15. Recent evidence from Germany suggests for instance that in electronic consumer goods (such as washing machines, but also notebooks), life cycles may have been shortened excessively from an ecological point of view. The higher energy efficiency of newer machines may not overcompensate for the higher amounts of energy and other resources used in production and disposal of machines which are replaced more often.[4]

IV. Possible causes of innovation adoption gaps

16. Bearing these caveats in mind, there are barriers that may impede the rapid adoption of innovations which can have a sizeable positive impact on sustainability. It is important to identify these barriers in order to design effective policies to close adoption gaps.

17. These barriers fall in the following categories:

(a) Externalities which distort market prices;

(b) Lack of salience of sustainability advantages (inattention);

(c) Credit constraints and other financial market imperfections;

(d) Information asymmetries between parties who must share costs and benefits of technology adoption.

(e) Coordination failures (“chicken and egg” problems).

demand, and to also keep the costs of exploitation from rising and the success rates of exploration from falling. Therefore, there is no evidence to suggest that supply will be outstripped by demand, and that prices will be pushed up “naturally”, thereby encouraging a shift towards renewables/alternative fuels. Similarly, innovation in electric vehicles will not automatically lead to a market breakthrough. A breakthrough will happen only if innovation in electric vehicles is more rapid than innovation in internal combustion engine vehicles (Covert, Thomas, Michael Greenstone and Christopher R. Knittel. 2016. "Will We Ever Stop Using Fossil Fuels?." Journal of Economic Perspectives, 30(1): 117-38).

[4] Federal Ministry of Environment (2016), The Influence of Usage Time on the Environmental Impact of Products, https://www.umweltbundesamt.de/sites/default/files/medien/378/publikationen/texte_11_2016_einfluss_der_nutzungsdauer_von_produkten_obsoleszenz.pdf (in German).

18. Distortions in market prices can negatively affect not only choices to invest in acquiring new technologies, but also choices on how to use them, as well as decisions to invest in innovation in the first place. These distortions arise from externalities, i.e. situations where decision makers (consumers or companies) do not bear the full costs or do not reap the full benefits of their choices, and where their choices therefore lead to excessively high costs or inefficiently low benefits for society as a whole. A classic example is a fuel price which reflects the costs of mining, refining and distributing the fuel, but not the cost of environmental pollution caused by burning it. In this situation, a consumer buying a car with a new more fuel efficient engine would bear the full cost of this investment, and would benefit from lower expenditures on fuel. However, if the price of fuel does not capture the cost of pollution, the owner of the more fuel efficient car will not reap the benefit of lower pollution. As a result, the demand for new cars may remain too low.

19. Even if externalities have been internalized and market prices are not distorted, innovations may still not be adopted as rapidly as would be desirable. One reason is that information on the sustainability properties of different products may be less salient to customers than other product features which then guide their purchase choices.

20. For instance the purchase prices of two alternative products can be compared easily, and will typically have a significant influence on the purchase decision. By contrast, whether an innovative product has lower usage costs may be much more difficult to assess, given that this depends on the technical properties of the product in conjunction with individual usage patterns. Future usage costs may thus receive less attention in purchase decisions.

21. Relatedly, adopting innovative sustainable technologies or products may require significant upfront investments. This is true for durable consumer goods, and even more so for innovative solutions in reducing the ecological impact of housing, or for investments in innovative sustainable production processes. The costs of adopting such innovations have to be incurred immediately, whereas the benefits in terms of reduced usage costs, lower environmental impact or higher revenues will materialize only over time. Such investments may therefore depend on the ability of consumers or companies to obtain credit.

22. There is ample evidence that consumers and companies, particularly small and medium-sized enterprises, are often constrained in their access to credit by a lack of collateral and by information asymmetries which discourage banks from lending. Such information asymmetries may be particularly relevant in the case of investments in innovative technologies where the return depends on product characteristics and future usage patterns that are difficult for creditors to verify.

23. Another possible barrier to the efficient adoption of innovations are information asymmetries between parties which must share the costs and benefits of the investment. An example is the decision by a landlord whether or not to use innovative materials to improve the insulation of a block of rental apartments. The landlord would do so if he could recover the costs through higher rents. The tenants would benefit through lower heating bills. However, it may be difficult for the two parties to agree on the appropriate size of a possible rent increase because the benefits will depend on the properties of the materials which the landlord installs, which the tenants do not control, and the heating habits of the tenants, which the landlord has no control over.

24. A fifth possible barrier can arise from coordination failures between the adoption of innovations and the development of complementary infrastructure (“chicken and egg problems”). For instance, consumers may be reluctant to purchase electrical cars or cars running on alternative fuels if there is a lack of charging stations, while the energy industry may be reluctant to build charging stations if there are few vehicles to be charged.

V. Policy options for addressing innovation adoption gaps

25. There are a range of policy options available to address the above barriers to the adoption of critical innovations, such as

(a) taxes and markets to internalize externalities;

(b) standards,

(c) regulations,

(d) product labelling,

(e) awareness-raising campaigns,

(f) subsidies,

(g) tax incentives and

(h) public procurement.

26. These policies may be used individually to address specific barriers, or they may be used in combination to address barriers arising from the inter-connectedness of adoption decisions in different areas.

27. Pigouvian taxes and, in the case of pollution externalities, markets for tradable permits, are generally considered the preferred policy instruments for internalizing negative externalities and correcting price distortions. The advantage of these instruments is that they are cost-effective because they do not discriminate between alternative technological solutions to sustainability problems and because they are generally well-targeted, i.e. they provide incentives for behavioural change primarily to those whose decisions are most distorted by market failures.

28. Where these options meet with political resistance, alternative policies that may be considered include subsidies for buyers or investors and mandatory quality or performance standards. These policies are generally considered second-best because they are less well targeted (subsidies) and may be subject to regulatory capture (standards).

29. Awareness raising campaigns, the introduction of product labelling and standards are examples of policies that can overcome the problem of lack of salience. Good practices include for instance offering free-of-charge energy audits which inform consumers of the specific usage patterns and costs of consumer durables and homes.

30. In this regard, information has a key role to play, and advances in information and communication technologies, such as the move towards the Internet of Things, hold a lot of promise. This move will generate large quantities of data, for instance about how household appliances are being used, and these data can in turn be used to inform consumers about the true costs of their consumption choices, and to create pricing schedules which provide incentives for a more efficient use of resources.

31. Incidentally, these policies can also address the problem of excessive obsolescence alluded to in section III above, i.e. excessively short life cycles of products in some areas. Furthermore, innovative service models of manufacturers, minimum requirements for software compatibility over time, and regulations and standards on improved reparability of products can be part of the solution here.

32. Awareness raising campaigns can also affect positive change in consumption patterns by changing behaviours through changing perceptions and aspirations. A case in point is the move to a “sharing economy” where people aspire less to owning durable consumption goods, such as cars, and focus more on being able to use them when they need

them. This provides examples of innovations which, although often enabled by technology, are essentially new business models enabling new modes of consumption.

33. Credit constraints and other financial market imperfections can be addressed through investment tax incentives and different forms of investment subsidies. But minimising the risk of inefficient public spending requires detailed understanding of technologies and markets.[5]

34. It also requires careful targeting. There is evidence that some subsidies, while intended to encourage investments of poorer, more credit-constrained households, have instead been taken up mostly by wealthier, less constrained households. "Tagging", i.e. restricting eligibility for subsidies based on observable characteristics such as income level can improve outcomes significantly.[6]

35. Financial incentives can also be combined with product labelling or standards, as when subsidized mortgages are made available to home owners who build to certain minimum energy efficiency standards.

36. There is also scope for providing additional incentives in areas such as green financing through changes in the regulatory environment for institutional investors.[7]

37. Information asymmetries between parties sharing the costs and benefits of adopting an innovation, and coordination failures between entities that need to make complementary investments can be mitigated through regulations and standards.

38. Barriers to the adoption of innovations often constrain the demand for innovation, even though, as indicated above, a lack of demand will also negatively affect supply. To address innovation adoption gaps, therefore, requires complementing supply-side policies with appropriate demand-side policies.

39. In addition to the policies discussed above, the state can be an important source of demand for innovation for sustainable development, notably through public procurement. For example, in the EU market, procurement accounts for about 19% of gross domestic product.

40. More generally, demand for innovation in areas critical for sustainability can be boosted by increasing the innovative capacity of the public sector to meet societal challenges.[8]

41. Public procurement of innovation (PPI) occurs when public authorities act as an "early user" customer for innovative goods or services. These are typically not yet available on a large-scale commercial basis and may include conformance testing. The procurer may be the user or catalysing/aggregating demand of others.

42. Examples of PPI include orders for products or technologies that do not yet exist but which are required to solve sustainability problems, technologies that are known and

[5] Karol Kempa and Ulf Moslener (2015), Climate Policy with the Chequebook – An Economic Analysis of Climate Investment Support. Frankfurt School of Finance and Management, Working Paper Series no. 219.

[6] Allcott, Hunt, Christopher Knittel and Dmitry Taubinsky. 2015. "Tagging and Targeting of Energy Efficiency Subsidies." American Economic Review, 105(5): 187-91.

[7] European Commission (EC) (2015), Shifting Private Finance towards Climate Friendly Investments - Policy options for mobilising institutional investors' capital for climate-friendly investment.

[8] See the Committee's document on good practices and policy recommendations on Innovation in the Public Sector ECE/CECI/2015/5 and Organization for Economic Cooperation and Development (2011), Demand-Side Innovation Policies.

proven but not at market scale, products new to the market (developmental PPI), and incremental or adaptive products (diffusion oriented PPI).

43. There are a range of challenges to promoting innovation through public procurement, including lack of expertise, limited interaction between buyers and sellers, fragmented markets, absence of strategies to link policy objectives, procurements and market/ technology developments, a perceived conflict between value for money and innovation, including a tendency or even imperative to favour lowest cost bids, and limited networking between procurers.

44. Key lessons from attempts to promote innovation through public procurement highlight the importance of:

(a) Needs identification: an outcome-based specification, with a long term perspective, and functional specifications;

(b) Market dialogue prior to the bidding process, openness to unexpected and innovative solutions, and engaging suppliers broadly at an early stage;

(c) Sound procurement methods, contract models, incentives, competitive dialogue;

(d) Engaging end-users and other stakeholders in the process early on;

(e) Exchanges of experience among public procurement agencies;

(f) Allocation of adequate resources to the pre-procurement and development phases of public procurement for innovation;

(g) Continuity: markets are not changed by a single project, and the market needs a signal of continuity in order to keep developing;

(h) ICT and new business models as key enablers of innovative solutions.

45. Smart cities have an increasingly important role to play in innovative procurement, and innovative procurement should increasingly become a part of standard practices in municipalities.

46. There is a need to move towards “smart” procurement programmes, and to influence the general attitude towards innovative procurement as an enabler for innovation. Smart procurement programmes can help shorten the time for innovations to enter the market, and provide a first market reference for innovative SMEs.

47. In one example, the European Union has made changes to procurement procedures, which are expected to increase the uptake of PPI. These include:

(a) Increased flexibility and simplification on the procedures to follow, negotiations and time limits;

(b) Clearer conditions on how to establish collaborative or joint procurements which, through bulk purchasing, can provide the necessary demand to launch new solutions;

(c) Strengthening the use of life cycle costing that describes all the phases through which a product passes from its design to its marketing, use, disposal and discontinuation of its production;

(d) The creation of innovation partnerships, which enable a public authority to enter into a structured partnership with a supplier with the objective of developing an innovative product, service or public work, with the subsequent purchase of the outcome;

48. Overall, PPI is gaining a greater role in innovation policy and is often linked to developing lead markets. PPI works best when integrated into a viable innovation system with capable suppliers and sophisticated procurers/agencies. However, even in less developed economies, PPI may be useful especially when the project can be linked to a wider system and innovation cycle. Global challenges and green innovation are increasingly becoming drivers of progress, with PPI an element in a package to support a greener economy and compensate for frequent failures of markets to take into account environmental and social costs.

VI. Good practices and policy principles

49. Beyond the specific policy options outlined above, there are a number of general good practices and principles which can be identified for the design of policies promoting the adoption and diffusion of innovations critical for sustainable development.

50. When designing policies or choosing among alternative policy options, especially also in the context of limited public budgets, policy makers may wish to consider the following criteria:

(a) significant impact,

(b) complementarity with other existing policies at the national and international levels,

(c) political feasibility,

(d) economic feasibility, and

(e) capacity of the public sector to implement the chosen policies.

51. Technology-neutral policies, which aim to promote certain outcomes (e.g. maximum emissions standards for vehicles), are generally preferable to policies which promote the adoption of specific technologies (e.g. subsidies for electrical vehicles), and which may result in missed opportunities from alternative technologies which may turn out to be superior.

52. Policy coherence and consistency is a challenge, particularly in areas where the goals of sustainability and social inclusion may conflict. One example would be where policies encouraging the adoption of innovative energy efficiency solutions for consumers coexist with policies subsidizing energy for households for social reasons.[9] Overcoming policy incoherence requires a coordinated approach across different government ministries.

53. Overcoming resistance to change by legacy industries to the removal of subsidies and the adoption of innovations may also be a challenge in this regard.

54. Because the impact of the broader adoption of innovations in one area may depend on the state of technology in another area, such as in the case of electrical vehicles and the sources of power for electricity generation, it may be necessary to coordinate and possibly sequence policies aimed at speeding up the adoption of innovative technologies in several connected fields.

55. Overcoming policy uncertainty is another key challenge, i.e. ensuring that investors (both customers adopting innovative products or technologies and innovators embarking on

[9] For instance, global road-sector subsidies for gasoline and diesel totaled USD110 billion in 2012. These subsidies tend to support demand for these fuels and thereby reduce the demand for alternatives, which in turn is likely to reduce incentives for innovation in this area.

the development of such products and technologies) have confidence in the stability of the regulatory and policy framework. Without this confidence, current regulations, standards, subsidies, taxes and tax breaks can only exert a very limited influence on purchase and investment decisions with a medium to long payback period.

56. When designing policies to promote the adoption of innovations critical for sustainable development, it is important to take into account their potential impact on international trade and investment. Among these policies are regulatory standards, carbon labelling, voluntary supply chain measures (if implemented by large players with market power, they become de facto mandatory), charges on embodied carbon, subsidies and product tax incentives, preferential finance terms, government procurement, and approved technology lists.

57. On the one hand, care needs to be taken that such policy measures comply with international trade rules and they do not become technical barriers to trade. On the other hand, product certification and traceability remain key challenges in order to ensure that policies such as the above do not lead to distorted trade flows. An example would be when products which comply with a domestic standard and are, therefore, more expensive are replaced by cheaper imports, which may not comply with the standard.

58. In this regard, there is also a need for more information about the large number of national standards, labels and certification schemes, such as for instance the UNECE Committee on Housing and Land Management is compiling for energy efficiency in housing.