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United Nations Framework Classification for Resources and United Nations Resources Management System guidelines and best practices for delivering the Sustainable Development Goals

Concept Note: United Nations Framework Classification for Resources and United Nations Resource Management System - Systems approach to enabling the resource as a service paradigm through blockchain technologies

Prepared by the Sustainable Development Goals Delivery Working Group of the Expert Group on Resource Management

Summary

This concept note provides the arguments for progressing towards a sustainable, integrated and more circular economy utilizing systems thinking. The "Resource as a Service" paradigm should be explored to shift the focus from commodity products to resources as a service outcomes. A shift of this kind needs to consider the complexity of the Resource Supply System. A blockchain technology approach to tokenization, tracking and traceability of both resources and monies is also seen to be of the essence in creating a systemic solution to many of the more egregious weaknesses and vulnerabilities of the linear socio-economic model or resource management. This concept note argues that the three complementary models discussed should be further developed and included in the United Nations Resource Management System tool kit.

Contents

I. Introduction to a Systems Approach to Natural Resource Management

1. February 2018 saw the first in a progressive series of - to date - four United Nations Concept Papers on changing the global resource management approach and the implications of adopting this change of approach for the development of the new United Nations Resource Management System (UNRMS) as a companion to the existing UN inventory tool for resources, the United Nations Framework Classification for Resources (UNFC). Of the four papers, this, the fourth, is the first since the release of the landmark UN publication **Transforming Extractive Industries for Sustainable Development**[1] (the **Policy Brief**), 25 May 2021.

2. The issue of the Policy Brief also coincides with prominent civil rights movements and climate activism. It intentionally connects the need for a paradigm change in resource management to redress the unwanted inequities, harmful legacies, and negative externalities imposed on future generations. These failures are among the root causes of public trust and confidence breakdown in the extractive industries. Of all the resources requiring such a paradigm change, the most urgent is a transformation of how the human resources of the planet are respected and engaged.

3. The **Policy Brief** was published after a six-month global consultation process conducted by the five UN regional economic commissions and led by the UN Secretary-General and his team. The Policy Brief draws on the conceptual framework for UNRMS as set out in the first three Concept Papers to lay out the compelling case for the step change:

> *"Transforming extractive industries […] will require giving equal weight to the management of the impact of extractives on societies and the environment, as has been given to economic considerations in the past. A shift in mindset is also needed away from short-term economic considerations to long-term financial risks and broader-based benefits associated with the transition to net-zero economies, that include social, environmental and cultural externalities."*

4. In its eighteen recommendations, which are unified through the common purpose to redefine the nature of investment decision-making in resource recovery and use for the benefit of all stakeholders, the UN executes a fundamental "step change" decision (Recommendation 15) to move the conceptual framework into practice:

> *"Implement a shared principles-based, integrated, sustainable resource management framework using tools such as the existing United Nations Framework Classification for Resources (UNFC) and the United Nations Resource Management System (UNRMS) under development."*

5. This recommendation has initiated but also committed the UN to adopt the UNFC and UNRMS tool kit as the instrument of choice for managing natural resources within the context of delivering the 2030 Agenda for Sustainable Development (2030 Agenda) and the 17 Sustainable Development Goals (SDGs) associated with it. To understand and better implement this decision, it is essential to review the key attributes of the UNFC and UNRMS tool kit, in particular, how the new approach differs from the approach it replaces.

6. In simple terms, the difference may be understood as the paradigm change from linearity to circularity, governing with equal and essentially indivisible, emphasizing the perfect convergence of flows of both the component "molecules" of the resources themselves and the "money" these molecules represent. In the fusion of molecules and money in a circular economy, the outcome in prospect is that the intended "social, environmental and cultural externalities" are delivered in a "win/win" beneficial equilibrium. This equilibrium is of the kind John Nash first identified as the quintessential attribute of a class of transition of primordial significance to equitable, transparent resource management. Either all stakeholders benefit in alignment with meeting their individual and several needs, or they all

[1] See UN Policy Brief, "Transforming Extractive Industries for Sustainable Development", United Nations, New York, May 25, 2021
https://www.un.org/sites/un2.un.org/files/sg_policy_brief_extractives.pdf

suffer the same systemic failure. In simple terms, the difference may be understood as the paradigm change from linearity to circularity, governing with equal and essentially indivisible, emphasizing the flows of the component "molecules" of the resources themselves and the "money" these molecules represent. In the fusion of molecules and money in a circular economy, the outcome in prospect is that the intended "social, environmental and cultural externalities" are delivered in a "win/win" beneficial equilibrium. John Nash identified this equilibrium as the quintessential attribute of a transition class of primordial significance to equitable, transparent resource management.

7. Hence it is in the equal interest of all to identify and hold to that "point of equilibrium" in managing resources in service of delivering the 17 SDGs. In that sense, secondary and primary resources may be understood equally as "critical materials".

A. The Pathway to the Circular Pivot

8. The first paper (2018) set out the case for a fundamental "Step Change" in resource management.[2] It changes the linear paradigm of single, commoditized resource management focused since World War Two on capital market investment to the paradigm set out in the Policy Brief. The approach of the United Nations Economic Commission for Europe (ECE) to managing resources, particularly energetic resources, is based on a circular, integrated "nexus-based" resource management paradigm.[3]

9. What is circular? In early 2018, the concept of circularity was beginning to take form, as referenced in the Step Change Paper:

> *"While there is as yet no normalized model of what a "circular" economy is, it is clear that a pivot is required from a linear model of natural resource management, characterized as "take/make, use, dispose" to a "circular" one characterized as take/make, use, retake/remake". In natural resource management terms, this means shifting from a one-step "extractive" to a continuous "recovery" modus operandi. In terms of materials flows, this likewise means that nothing unnecessarily or unavoidably leaves the boundaries of the eco-system, i.e. there is "zero waste".*"[4]

10. This new paradigm, which could be based on the Nash equilibrium point, is being rapidly consolidated today under the Environmental, Social and Governance (ESG) investment and finance rubric. As is now clear, ESG finance is fully aligned with, and ideally suited, to reporting by the global resource sector on its contribution to meeting the expectations of 193 UN Member States of the global resource sector in enabling delivery of the 2015 Sustainable Development Goals (SDGs). This is precisely because ESG reporting "social, environmental and cultural externalities" are placed front and centre as the definitive key performance indicators, exactly the key performance indicators of the 2030 Agenda 230.

11. The second paper (April 2020) sets out a high-level description of "specifications, guidelines and best practices" for UNRMS under the rubric "Global values, regional circumstances, priorities and needs for resource management in the age of big data and artificial intelligence".[5] It established the potential for applying powerful, widely distributed, affordable, "smart" data capture, analysis and communications tools in particular blockchain,

[2] See UNFC supporting the attainment of Sustainable Development Goals Transforming our world's natural resources: A step change for UNFC? https://unece.org/fileadmin/DAM/energy/se/pp/unfc_egrm/egrc9_apr2018/ece.energy.ge.3.2018.7_e.pdf

[3] See Natural Resource Nexuses in the ECE region https://unece.org/info/Sustainable-Energy/UNFC-and-Sustainable-Resource-Management/pub/355180

[4] Ibid.

[5] See Development of detailed specifications, guidelines and best practices on effective use of the United Nations Framework Classification for Resources and the United Nations Resource Management System for sustainable development: Global values, regional circumstances, priorities and needs for resource management in the age of big data and artificial intelligence. https://unece.org/fileadmin/DAM/energy/se/pdfs/egrm/egrm11_apr2020/ECE_ENERGY_GE.3_2020_7_SDGD_WG_final.pdf

but also smartphones, satellite data, machine learning and artificial intelligence to this task, predicting that the COVID-19 pandemic would accelerate the transition to such an approach.

12. Most of the resources needed for sustainable development are supplied from thousands of individual projects (mines, oil fields, wind farms, etc.), the behaviour of which is usually reasonably understood. However, for the aggregate of these projects, it is a dynamic, complex adaptive system, with hundreds of components and many links and dependencies between them. For a system of this nature, the response to a change is typically non-linear and unpredictable. A resource supply system may become necessary to better understand the supply chains and their complex interactions, especially in an increasingly circular economy. Such a system will ensure that resource supply will be assured, especially in the dynamic times when energy and mobility transitions get momentum.

13. Moving towards a more circular world will be the essential decoupling of resources and development. Decoupling requires a focus away from commodity products to consumers and service outcomes. The "Resource as a Service" paradigm shifts the focus from products to consumers and outcomes (see Section III for more details). The service focused transition will foster a more circular economy. A shift of this kind needs to consider the complexity of the resource supply system. The supply network can become quite complex with multiple resource sources, production centres, beneficiation, refining and processing steps involved (see Section IV for details). The complexity only increases when a progressive circular economy is considered. Of the essence in the highlighting of the blockchain approach, its attributes, as known by its more technical name of Distributed Ledger Technology, were seen to be of the essence in creating a systemic solution to many of the more egregious weaknesses of the linear socio-economic model (see Section V). These technologies could be integrated into a resource supply system that caters to resources as a service business model. These technologies are summarized in a definitional manner as follows: "[blockchain comprises] the technological infrastructure and protocols that allows simultaneous access, validation, and record updating in an immutable manner across a network that's spread across multiple entities or locations".[6]

14. As explored further in the opening sections of this concept note, the systems approach noted in the 2020 second paper is key to its adoption by stakeholders and its technical enhancement:

> *"The "new" world will be increasingly AI, big data and blockchain-enabled. It will have a systems approach as its core philosophy for maintaining sustainable growth."*

15. But the point of taking a systems approach was not restricted to the technology itself – in fact, the opposite. Because the circularity transition from a resource perspective needed to be focused on integrated resource management, the conceptual point of departure was pinpointed by determining what the resources might be to meet critical needs in the service of delivering the SDGs:

> *"In the past few years, these [blockchain and AI] capabilities have been very powerfully applied to better understanding and hence mitigating chronic stresses on vital resources the world depends on for meeting basic needs, notably Food, Energy and Water (FEW). These stresses are now recognized to be interdependent, leading to a focus on the so-called FEW nexus. Sustainable management of this resource nexus is seen as one of the paradigms which UNRMS has to service."*

16. In that context, and given the recognition that the circular economy would fuse into a single "currency" molecules and monies from an economic perspective, it was inevitable that a transformative change in investment strategy and criteria would be necessary.

[6] See Distributed Ledger Technology (DLT) https://www.investopedia.com/terms/d/distributed-ledger-technology-dlt.asp

B. Towards a new sustainable point of environmental-economic equilibrium

17. In April 2021, completed during the Policy Brief consultation process, to which some of its key points were presented at the ECE Roundtable in the series (Roundtable on Extractive Industries and Sustainable Development in the ECE Region, 20 January 2021), the third concept note set out the case for a step-change in the standard way of measuring the success of an investment in resource management. The game-changer shifts from a single performance criterion, return on investment or shareholder return or its equivalent increase in Net Present Value, to a complex series of key performance indicators defined by "social, environmental and cultural externalities". In more philosophical terms, this metric change is the lever that moves investment from shareholder focused to "stakeholder capitalism".[7]

18. This shift identifies resources critical to meeting essential human needs classed as a public good in the new Nash equilibrium. In the context of SDG delivery not just for 2030 but for the longer, "circular" term, the driving public good class priorities include:

(a) Assuring the supply of critical materials and resources, whereby criticality may be meant ending poverty and zero hunger at an individual level, but also zero waste and zero harm at a resource nexus level; or

(b) Enabling the resilience and security of an economy at an inclusive societal level, thereby in combination regarding specific resources as a public good to which secure equitable access is a right for all stakeholders, not a privilege of ownership or restricted access.

19. In a period of acute crisis formally initiated on 11 March 2020, as the COVID-19 pandemic started, components included in the critical materials resources set are both the enduring requirements of water, energy and food but equally, vaccines and related delivery infrastructures. The alarming loss of fertile topsoil is of particular importance, which should also be considered a critical resource.[8]

20. In that way, the third paper made good on a commitment made by the then ECE Executive Secretary in opening the 2017 annual meeting of the Expert Group on Resource Classification (subsequently renamed the Expert Group on Resource Management) when he set the goal for the step change to come as a pursuit of Public Good in resource management. The founding premise which triggered the whole series of Concept Papers in the first place was:

> *"… the need to change the narrative on resources from one of unbalanced production, which leaves behind significant externalities, to one where more value will be created [the desired outcome] of the work being undertaken on resource classification and the value of UNFC as a public good."*[9]

21. From this impulse followed the change in mission and scope for the Expert Group on Resource Classification from a focus on a classification to management directly, as reflected in the name change to the Expert Group on Resource Management, and hence from a one-pillar system, the Framework Classification to a two-pillar model including a Resource Management System.

22. If a reminder were needed to the Expert Group that providing such a system would meet a need within the UN itself, another Division within ECE itself started to commission the development of a blockchain app, FeedUp,[10] focused on a key circular economy goal, the

[7] See Klaus Schwab, Stakeholder Capitalism, Stakeholder Capitalism: A Global Economy that Works for Progress, People and Planet, (Wiley, January 2021).

[8] See "For A Conscious Planet, Focus Should Move Towards Soil" https://www.news18.com/news/opinion/opinion-for-a-conscious-planet-focus-should-move-towards-soil-4521236.html

[9] See Report of the Expert Group on Resource Classification (2017) https://unece.org/fileadmin/DAM/energy/se/pp/unfc_egrm/egrc8_apr_2017/ece.energy.ge.3.2017.2_e.pdf

[10] For FeedUP see http://feedup.unece.org/

reduction and eventual elimination of food waste. This app is now in pilot testing and offers an excellent example of how developing a FEW nexus resource management system can be approached. ECE and the United Nations Centre for Trade Facilitation and Electronic Businesses (UN/CEFACT), jointly with key industry stakeholders have looked into such challenges and risks and have launched a project for an international framework initiative to enhance transparency and traceability for sustainable value chains in the garment and footwear industry.[11] As part of that work, ECE has launched "The Sustainability Pledge" inviting governments, garment and footwear manufacturers and industry stakeholders to pledge to apply our tool kit of measures and take a positive step towards improving the environmental and ethical credentials of the sector.[12] Similar initiatives such as ESG Book,[13] where environment, social and governance data are provided as a public good, are beginning to disrupt a traditional capital market industry. The trend is sweeping the wider society, reflected by the United Nations Educational, Scientific and Cultural Organization (UNESCO) Open Science initiative for the broader adoption of open practices to strengthen the links between science policy and society.[14]

C. The Circular Economy transition - an ethical transformation

23. The recent civil unrests give rise to the inescapable conclusion that the failure of the linear model of resource “extraction” has its social and ethical origins in the colonial approach to the human resources on which this “extraction” critically depended. It could be through forced enslavement or highly exploitative and repressive employment practices. The colonial linear model, starting with its defining characteristics of removing resources from their point of origin at meagre cost, shipment to a third country for value recovery while leaving a legacy of environmental damage and waste, often with severe accompanying occupational and public health consequences, has unmistakable linkages to - it may be argued critical dependencies on - slavery.

24. So successful was the model that it was replicated in the nineteenth within third countries and part of the transformation of the nature of cities, notably in Europe, to becoming magnets for cheap labour and the urban poor. This became the antithesis of the Nash win/win equilibrium. The battles that ensued for access to critical resources became increasingly entwined with win/lose conflicts.

D. The Pivot to the New Point of Equilibrium

25. With the publication of the Policy Brief, the required “step change” occurred at least for the roles of UNFC and UNRMS, which together are presented as central to the UN’s post-COVID approach, not least to investment in the Build Back Better recovery phase. That for the first time gave a formal mandate to the use of UNFC and UNRMS as the UN’s implementation tool kit while also affirming the UN’s confidence that this tool kit will materially assist the delivery of resource-related SDGs.

II. UNFC and UNRMS

26. Crises such as droughts, floods, hurricanes, forest fires and the current and ongoing COVID-19 pandemic put severe pressure on the planet. These crises have a significant and

[11] See Traceability for Sustainable Garment and Footwear https://unece.org/trade/traceability-sustainable-garment-and-footwear

[12] See https://thesustainabilitypledge.org/toolbox.html

[13] See ESG Book aims to 'disrupt' the sustainability sector with free data from commercial investors as much as from public sources of funds https://www.reuters.com/business/cop/esg-book-aims-disrupt-sustainability-sector-with-free-data-2021-12-01/?utm_source=newsshowcase&utm_medium=discover&utm_campaign=CCwqFwgwKg8IACoHCAow3MukCjD92XcwpIsrMLv7MA&utm_content=related

[14] See “UNESCO sets ambitious international standards for open science” https://www.unesco.org/en/articles/unesco-sets-ambitious-international-standards-open-science

immediate bearing on how resources are produced, distributed and consumed, revealing significant stresses on supply chains and the industries they serve when the personnel that service them get sick or incapacitated. Such extreme events are difficult to predict through traditional methods. A new paradigm for managing overstretched human and technical resources during complex acute events is needed.

27. There is a need for global, principles-based action to develop a coherent framework for resource industries if the world is to meet its climate objectives and deliver a quality of life at the community level. ECE proposes action on a five-point framework for resource industries that would include:

(a) **Social Contract**: a comprehensive Socio-Environmental-Economic Contract to Operate is needed that integrates quality of life, just transition, climate change mitigation and adaptation, and environmental stewardship;

(b) **Sustainable Finance Taxonomy**: Investors should move towards ESG-focused funding based on a common sustainable finance taxonomy;

(c) **Sustainable Resource Management System**: The industry should align with a shared Principles-based, Integrated, Sustainable Resource Management Framework;

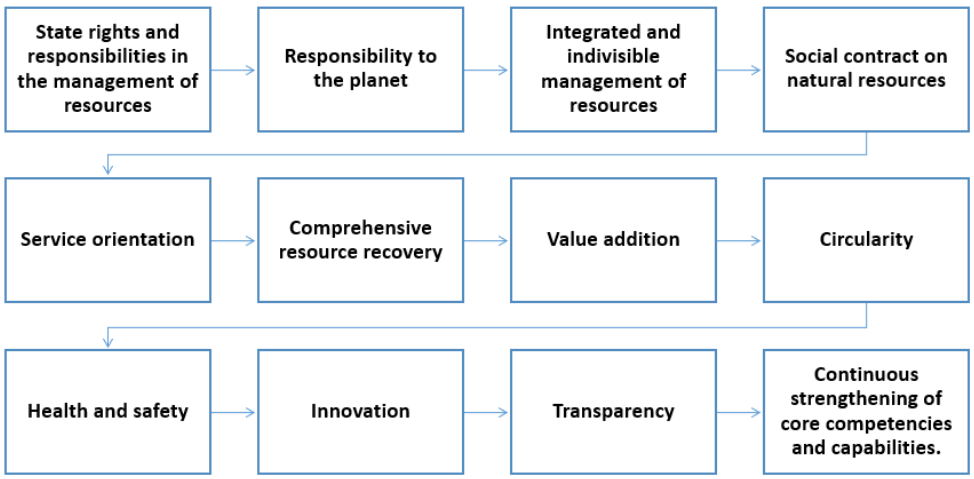
(d) **Supply Chain Traceability**: Stakeholders can develop a comprehensive framework for traceability, transparency, and sustainability in extractives related supply chains;

(e) **Strategic environmental assessments** of plans and programmes help mitigate possible negative impacts. They can be a comprehensive planning tool that promotes governance and innovation by weighing the environmental and health impacts of alternatives, identifying solutions, and engaging authorities and the public.

28. ECE has recognized the resource implications of the 2030 Agenda and has engaged actively with all stakeholders to strengthen and widen the application of UNFC as the basis for UNRMS. The social license to operate is an important issue, so social and environmental guidelines have been developed. The scope of UNFC has been extended to include all primary and secondary (anthropogenic) resources.

29. Together, UNFC and UNRMS provide a unified, comparable, interoperable and harmonized approach to resource assessment and management that can be used for governmental, statistical, social, corporate and financial purposes. They provide a robust set of standards, guidelines, protocols and best practices for attaining the 2030 Agenda at the core of sustainable resource management (Figure I). Rebuilding economies after the pandemic will require massive amounts of critical raw materials for green energies.

Figure I
Fundamental principles of UNRMS



30. Countries and companies adopting sustainable resource management aligned to UNFC and UNRMS will improve resource development projects' socio-economic viability and technological readiness and ensure responsiveness and resilience to regional and global challenges. The action will trigger opportunities for governments, industry and financiers to reimagine their businesses and put themselves firmly in the sustainable development discourse:

- This transformation will include improved environmental management of the projects, for example, a vastly reduced impact on land, soil, water and air and significant waste reduction
- The projects will be socially responsible and increase local community impact to deliver higher benefits to the local communities, including indigenous populations.

31. Regional and national tailoring to needs is a prerequisite for sustainable resource management. For example, the European Union (EU) emphasizes strategic considerations and new, more sustainable resource provision paradigms. The EU made €80 billion funding available to innovation through the "Horizon 2020" programme 2014-2020. A further €100 billion will be available for 2021-2027 through the proposed "Horizon Europe" programme. UNFC is bridged to the Oil and Fuel Gas Reserves and Resources Classification of 2013 of the Russian Federation and aims to do the same with its minerals system and pilot the use of UNFC in the Commonwealth of Independent States (CIS) region. Other countries in Central Asia and South-East Europe follow similar integrated approaches.

32. In Asia, resource scarcity contrasts with growing demand. Resource demand in both China and India is not matched by domestic availability, requiring both countries to adopt a three-pronged approach to security of supply: (i) increasing primary production; (ii) exploring secondary production including from unconventional resources; and, (iii) seeking global access. The Chinese petroleum and mineral systems are bridged to UNFC. China seeks to support stakeholder institutions involved in resource management.

33. Africa provides another extreme of various pressures at play. Maximizing revenues with little regard for a better fiscal regime has plagued the region for a long time. Many countries in the region stand out for their lack of policies in resource management and still depend on negotiating development contracts on a case by case basis. With the lack of negotiating and contract writing experience, many countries stand in an asymmetrically weak negotiating position vis à vis the commercial operator or investor. Led by the Africa Mining Vision (AMV), a UNFC and UNRMS-based African Mineral and Energy Resources Classification and Management System (AMREC) is now developed by the African Union (AU) to restore equilibrium between the negotiating parties, precisely as Nash demands.

34. The Americas, blessed with abundant natural resources, have indigenous populations or the First Nations issues. Rich culture, often captured in the timelessness of monuments and archaeological sites, is an area of intersection with resource development. Mexico has piloted UNFC for identifying and classifying the social and environmental aspects to project advancement in a number of their development areas.

35. International Centres of Excellence on Sustainable Resource Management (ICE-SRM) will be a collaborative network of organizations focused on supporting the sustainable management of the resources needed for development in line with the 2030 Agenda and the Paris Agreement.[15] The Centres are conceived to fully comply with the adopted ECE standards and guidelines – policy support, technical advice and consultation, education, training, dissemination, and other critical activities for stakeholders involved in the sustainable development of national resource endowments.

36. ICE-SRMs will promote within its activity footprint the global deployment of UNFC and UNRMS to describe the resources needed for the attainment of the 2030 Agenda for Sustainable Development and support their management. ICE-SRMs are under consideration

[15] See https://www.unece.org/fileadmin/DAM/energy/se/pdfs/UNFC/ICE-SRM/20200925_EGRM-11-2020-INF3_ICE.SRM_Criteria___ToR_Final.pdf

by many countries and regions around the world could be the platforms on which global as well as regional needs can interplay and support a new system that is focused on resilience

III. Resources as a Service

37. If the objectives of the 2030 Agenda have to be met, there will be a need for an uninterrupted supply of natural resources. Rising population and increasing urbanization will put pressure on the demand. Current patterns of consumption of resources are highly skewed, with high-income countries consuming over 25 tonnes per person per year. In contrast, the least developed economies consume less than 2.5 tonnes per person per year. As living standards improve, consumption rates will increase, and the overall quantities consumed will increase drastically.

38. It is not enough to increase production to meet the demand for resources. An unmitigated increase in production will have a significant environmental and carbon footprint. With grades of mineral resources becoming poorer and mining and petroleum products from increasingly difficult sources, the Energy Return on the Energy Invested (EROEI) is squeezed. These factors mount as insurmountable problems, diminishing the social contract on natural resources.

39. Resource use efficiencies need to be improved drastically. Decoupling development and resource use are needed, which means getting more out of fewer resources.[16] However, the current volumes of resources and materials recycled are just 8 per cent, which points out deeper issues within the system. The current commodity models are developed for a linear economy. They are ill-suited for supporting the circular economy paradigm.

40. An alternative to the commodity model is the service model that considers "Anything as a Service". This model recognizes the vast number of products, tools and technologies that vendors now deliver to users as a service. Currently, "as a service" transforms every industry globally, including retail, journalism, manufacturing, media, transportation, and enterprise software. Today, many significant companies generate most of their revenue from services, not commodities or products. Commerce is reorganized around the subscription model, which gives the companies predictive revenue.

41. The focus has now shifted from products to consumers and outcomes. The product is discrete and transactional but focusing on consumers and outcomes represents enduring value. Product mindset prioritizes add-ons and revenue extraction and devalues customers. Product cultures are built around thinking, and assembly lines organize everything across a perfectly straight line. That no longer works for many industries. A subscription culture is gaining hold, ensuring the customer succeeds with the service over time, translating that lasting value into revenue. Every sector on the planet has the same potential to latch on to the same kind of customer- and outcome-focused growth.

42. The commodity mindset is even further away from the product mindset. The customer is even more obfuscated; therefore, the company has a low customer focus. In turn, a commodity company does not occupy a valued position in the customer's mind. The lack of visibility from both sides makes company growth and customer growth unrelated. This boils down ultimately to the breaking of trust at a community level.

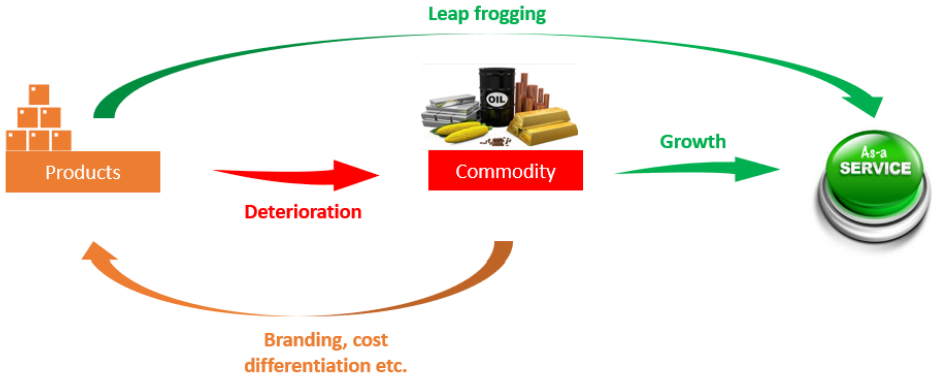
43. An industry focused on services will not produce more commodities but on seeing how fewer resources are required to produce a particular outcome. Resource efficiency will be at the core, which translates to efficient production with the least environmental or climate footprint. The industry and the users become real partners and grow together. Customer loyalty will permeate society, and an actual social contract on natural resources is fostered.

44. It will not be difficult for the "commodity" industry to transform into a service industry (Figure II). As with many sectors, the manufacturing industry is transforming. Instead of being focused on products, inventories, and promotion, the industry is razor-focused on the audience, its customers. The transition to a service industry has been less

[16] See UNEP (2019) Global Resources Outlook https://www.resourcepanel.org/reports/global-resources-outlook

painful than imagined for any industry that has walked this path. Information technology (Software as a Service, Artificial Intelligence as a Service, Blockchain as a Service, etc.), media (Content as a Service), manufacturing (Product as a Service) and transport (Transportation/Mobility as a Service) provide a few good examples of this transformation. The commodity industries should wake from their long slumber to the new world of "anything as a service."

Figure II
Possible pathways to transforming the "commodity" industry to "as a service" industry



45. The service-focused transition will foster a more circular economy. Inefficiencies in resource use will be replaced with maximum resource efficiencies and decoupling for development and resource use. The industry could have the advantage to potentially gain from escaping the vagaries of market volatilities, forever transitioning through "boom and bust" cycles. Even if the vagaries are not fully controllable for complex supply chains, at least a better prediction and preparedness will be possible. The stability of the resource market will benefit governments, who can anticipate stable economies and thus plan better. The transformation will foster overall bring the more equitable distribution of benefits across all stakeholders to the society, thus firming upsetting firm foundations for the social contract on natural resources.

IV. The Resource Supply System

46. Our society relies on using many types of resources (metals, oil and gas, coal, electricity, water, etc.). Most of these are supplied from thousands of individual projects (mines, oil fields, wind farms, etc.), the behaviour of which is are usually reasonably understood. This is not the case for the aggregate of these projects, which forms a dynamic, complex adaptive system with hundreds of components and many links and dependencies between them. For a system of this nature, the response to a change is typically complex, non-linear and unpredictable. This section is intended to address the challenge of complexity by providing a simplified, schematic overview of the resource supply system. A few references provide more background on the topics for readers who wish to explore the supply system in greater depth.

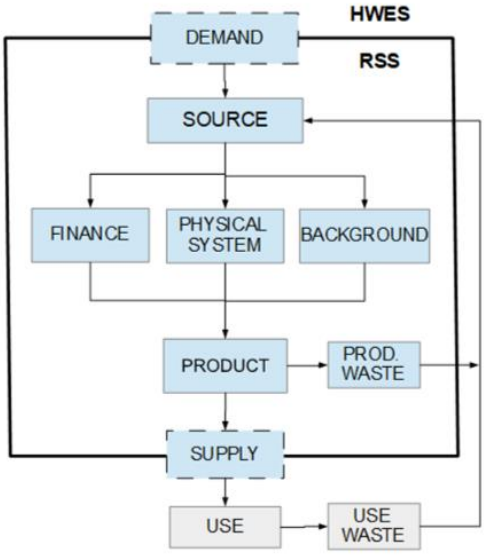
A. Basic Resource Supply System

47. A Resource Supply System (RSS) is a set of activities that must be carried out for a product to be supplied and is a small part of a more extensive human world economic system (HWES).[17] It consists of several basic components: source, physical system (production, transport, processing), financial, economic, and background (legal, regulatory, etc.).

[17] For want of a better term this maybe denoted as the Human World Economic system (HWES) which itself is part of a wider system.

48. Although not presenting the full scope of complexity, it can be instructive to consider a resource supply system isolated from the HWES. The block diagram below shows the fundamental components of an RSS. The heavy black line indicates the boundary between the RSS and the HWES. In this way, it lays out a notional, high-level architecture for a system such as a blockchain. Still, it is not intended to represent an entire system, which would necessarily be much more detailed (Figure III).

Figure III
Basic components of the resource supply system architecture



49. The boxes with dashed outlines in Figure III indicate the entry and exit points to the RSS, Demand and Supply, respectively. Boxes with a thin outline and a light grey background lie outside the RSS. The entry point to an RSS is the recognition of a signal of:

- **Demand** the expression of a user's desire and ability to acquire a product. It is the fundamental force that drives economic activity and the interface to an RSS between the world and resource supply systems. When conditions warrant, notably a considered balance between risk and economic viability, it may trigger action by an
- **Agent,** to seek a source. An agent is an autonomous entity with defined properties that carry out prescribed activities. It is used in Agent Based Modelling to represent many types of entities. It may be an individual (e.g., a company or government) or a collective set (e.g., a combination of several companies or government organizations). The properties and behaviour can differ and can change over time as it reacts to the information that it receives from other agents and the environment in which it operates.
- **Source** that, when identified and assessed to be viable, is subject to a
- **Physical system** controlled by operating agents:
    - Production agents
    - Processing agents with facilities that turn a raw resource into the desired product
    - Transport agents that move the resource quantities through the system.

50. In addition to the physical system, other conditions that must be satisfied are:

- **Financing**, the lifeblood of the system and supplied by a Financial Agent such as a bank or securities, private equity, government, sovereign wealth funds, green bonds etc.
- **Background** requirements that are typically beyond the control of an operating agent. They include:

- Legal issues such as entitlement
- Regulatory process
- Political issues
- Environmental and social issues

51. When the above conditions are satisfied, a

- **Product** (see Section IV.E for more on Product) is created that exits the RSS at a
- **Supply** point that represents a transfer point on the boundary of the RSS and the HWES for
- **Use**, an externality that is not addressed by UNFC or UNRMS and represents the manufacturing system and consumer usage that provides the amenities on which our society relies.

52. **Waste**: At each stage of activity, processes in the RSS and also outside it in the HWES leaves a residue. This is considered "waste" but may subsequently be considered to contain a potential desirable product. In the simple model above, a "Recycle" loop may feed this back into a source inventory and represent a Circular Economy.

B. Resource Supply as a Complex System

53. The architecture of the block diagram (Figure III) may be understood as a normalized snapshot of the drivers, resources and workflows of a project. In reality, each block can include many, often hundreds, of agents or activities connected by many links in a network that forms a dynamic adaptive complex system. Blockchain technology has been developed to make the management of this complexity easier and more efficient. Resource management involves identifying and using the "levers" that may be manipulated in this system to produce the desired result. The properties of such systems have been extensively studied (see References). They may:

- Have emergent properties that are not apparent from the components considered alone
- Have cascading changes when a change in one component ripples through the system, causing unpredictable changes in other components
- Have abrupt, critical changes in response to minor stimuli.

54. This has significant implications for attempts to "manage" resource supply. What do you/can you manage? How do you identify the levers? How do you predict the consequences of pulling a lever?

C. Modeling Resource Supply

55. The resource supply system can be studied using:[18]

- **Flowcharts**, which mainly illustrate sequential operations
- **Networks**, in which nodes represent the agents connected by links, may have a high degree of complexity and can be used to study the dynamics of a resource supply system
- **Agent Based Models** (ABM) can simulate the actions and interactions of the individual components of an RSS to search for explanatory insight into the collective behaviour of the system and can be used to study agents and the result of their dynamic interaction.

[18] The descriptions given here are simplified and additional information can be found in the references.

56. An agent-based model (ABM) has components:

- An **Agent**, an entity with defined properties that carry out prescribed activities and its properties and behaviour can change over time and is represented in an ABM as a **Node**.[19] Examples of agents could include:
    - A Production agent explores a mineral, mines, sells products, etcetera
    - A Transport or Processing agent
    - A Funding agent, such as a bank or securities market, provides the funds for physical activities
    - Others.
- **Links** that join and control Agents' actions and can show the flow of resource quantities and finances**.**

D. What is Resource Management?

57. The ability to manage resource supply depends on understanding what a resource is, but a footnote in the UNFC Update 2019 states that the term "resource" is used only in a generic sense.

58. The term "Product" is included in the UNFC Update 2019 glossary without specifying a reference point and needs some clarification. A distinction needs to be made between its use for UNFC where it may be a quantity in any" box," flowing to the endpoint of a resource supply system, the UNFC boxes 111, maybe 112 and 113, from which a flow of energy or material passes outside the scope of UNFC to a User. For instance, for a User:

- Copper is the product, not the initially mined ore or a copper concentrate. It will be the metallic copper delivered to a user, but not the goods that may be manufactured from this copper
- Oil that may have been pre-processed for transport and delivery to a refinery. It will not include the refined output
- Clean electricity that is generated from solar, wind, water, or bioenergy and delivered to a user, not its subsequent use.

59. It might be appropriate to define a quantity with a reference measurement point at 111 (possibly 112 and 113) of UNFC as a **Final Product**. All other quantities would be defined as **Intermediate (EFG) Products** within the body of the UNFC cube.

60. The purpose of "resource management" is to manage the supply as it passes through the "boxes" of UNFC to provide a Final Product to a User in a sustainable manner.

61. A possible definition of ***what*** it is:

"An active process to provide the timely and efficient supply of a required Final Product to Users."

62. ***How*** it is carried out is of critical importance and should meet the following conditions (and maybe others):

- Resource production and use should minimize deleterious environmental and social impacts
- Changes in resource supply, especially shortfalls, and use can have a significant disruptive impact on society and should be measured to limit adverse societal effects.

63. Balancing these potentially conflicting conditions is a significant task.

[19] Networks and Agent based models use different terminology. Networks: Vertex; Edge. Corresponding terms in AMMs: Node; Link.

E. Resource Management System Glossary and Definitions

64. It is proposed that a definitive Resource Management System (RMS) glossary be developed.[20] UNFC and UNRMS currently include minerals, petroleum, nuclear fuels, renewables, anthropogenic resources, injection projects and groundwater. New resources such as hydrogen and ammonia are being considered. But the natural resource base will also include land, soil, water (surface and underground), forests and food resources.[21] The development of a harmonized glossary is not a trivial exercise.

65. A clear understanding of UNFC and the RMS terms is essential, but the current UNFC glossary is limited. Some terms are defined or assumed to be defined in resource-specific documents such as the Petroleum Resource Management System (PRMS) and the Committee for Mineral Reserves International Reporting Standards (CRIRSCO) Template but need to be revisited.

66. A glossary may contain definitions, examples, and explanations; they should not be confused. The definition should describe what it is, not what it does, and not only by an example or an explanation. For instance, the current UNFC definition of a Product is:

> *"Products of the project may be bought, sold or used, including electricity, heat, hydrocarbons, hydrogen, minerals, and water. It is noted that with some projects, such as renewables, the products (electricity, heat etc.) are different from the sources (wind, solar irradiation etc.). In other projects, the products and sources may be similar, e.g., in petroleum projects, both the sources and products are oil and/or gas, although the fluid state and properties may change from reservoir to surface conditions."*

67. This describes what is done to a product and explains without saying what a Product is. A more appropriate definition could be:

> *"Product is a quantity of material or energy that is measured at a point of reference that may be one of the UNFC Classes."*

68. Explanations and examples can supplement this definition.

V. Assessment of Blockchain Model

A. What may be expected of Distributed Ledger Technology – Blockchain?

69. It is no coincidence that the Policy Brief (Chapter II) connects the legacy of this systemic failure to resolving one of the critical targets of the circular transition, "illicit financial flows, including corruption and tax evasion". When aggregated together, these phenomena come at a very high and persistent annual cost to many countries with a high reliance on their role as a supplier of critical and other resources to third countries, most notably those third countries with high-income economies. As discussed in greater detail below in the section dedicated to blockchain, the nature of its distributed ledger technology is to provide a "designed in" solution to such challenges, enabling full end-to-end/continuous traceability and transparency simultaneously of molecules and monies.

70. In the process, a perhaps even more significant transformation occurs, which is the removal of a long-established distinction in the linear extractives model between "fungible" and "non-fungible" assets. The normalization endpoint of the distinction is the commodity status of the extracted resource, whether solid, liquid or gas, where one unit within the resource nexus – e.g. copper concentrate, natural gas or milk – is wholly interchangeable with or substitutable by another of identical type.

[20] A Glossary of Common Terms for UNFC has been developed (ECE/ENERGY/GE.3/2022/3).

[21] See Natural Resource Nexuses in the ECE region https://unece.org/info/Sustainable-Energy/UNFC-and-Sustainable-Resource-Management/pub/355180

71. But if the blockchain procedure is carefully followed of tagging (tokenizing) all resources as recovered into use, starting with recovered and reused secondary resources as always having primacy over primary resources, then the unique nature of each resource unit, whether of a single or multiple resource composition, in effect renders every resource unit unique and hence "non-fungible". The move to resource as service is inevitable and straightforward from this transformative step.

72. The "fungible" premise, which is adduced to class resources in their physical state as commodities – perhaps unintentionally – creates a powerful incentive to managing resources in such a way that they are untraceable, unaccountable and as such open to intentional diversion and falsification as well as unintentional wastes. Zero waste thereby becomes a designed-in outcome of circularity, delivered by blockchain, as well as an ethical tenet of sustainability.

B. A pragmatic assessment of blockchain model for resource management

73. The adoption of blockchain technology inherently solves several issues within the linear supply and value chain - loss of data integrity, lack of transparency, traceability and impenetrable or ineffectual governance, resulting in illicit funds flows - through its Distributed Ledger Technology (DLT) functionality:

> *Distributed Ledger Technology (DLT) refers to the technological infrastructure and protocols that allow simultaneous access, validation, and record updating in an immutable manner across a network spread across multiple entities or locations.*

74. With a focus on the positive consequences for finance and investment, which of course in the fused world of monies and molecules of the circular economy equally apply to illicit flows of materials as well as of funds, IBM in its definition of blockchain triangulates traceability, asset management and trust: "Blockchain is a shared, immutable ledger for recording transactions, tracking assets and building trust."[22] A key attribute is its capacity to:

> *"…tokenize natural resources, giving them a unique digital identity (similar to a digital coin) that people can trade. This makes the value of resources more apparent, facilitating a new system of pricing and trading natural resources and incentivizing people to adopt Circular behaviours."*[23]

75. When these attributes are set opposite the quantification of losses that the Policy Brief citing a United Nations Conference on Trade and Development (UNCTAD) Report (2020), identifies as a consequence both of flows of illicit funds (the effect?) and the causes of this issue, the fit between the Policy Brief problem definition and the Technology solution offer could hardly be tighter:[24]

> *"In Africa, UNCTAD estimates that $88.6 billion in illicit financial flows leaves the continent every year, more than the total amount of the annual $48 billion received in official development assistance (ODA) and $54 billion in foreign direct investment. Governance deficits and weak environmental, social, legal and policy frameworks and coordination mechanisms between and within sectors and between national and local levels are also a concern to export-dependent countries."*

76. A significant advantage of blockchain lies in the use of "smart contracts", in which by "smart" is currently meant essentially "automated" in terms of a contract can be embedded in the system, with the contractual terms and conditions available in a transparent and verifiable form. When the terms are met, the transaction is executed automatically, and a new block is added to the chain recording the fulfilment. Tampering with or falsifying a record is

[22] See https://www.ibm.com/uk-en/topics/what-is-blockchain

[23] See Mark Lancelott, Nic Chrysochou, Patrick Archard, PA Opinion, PA Consulting https://www.paconsulting.com/insights/blockchain-can-drive-the-circular-economy/

[24] UNCTAD (2020). Tackling illicit financial flows in Africa for sustainable development in Africa. Geneva: UNCTAD, 248 pp. See https://unctad.org/system/files/official-document/aldcafrica2020_en.pdf

also significantly more complex and traceable. Any change in transactions resulting from such interventions generates a new block recorded as part of the chain.

77. Since unintentional human error is also a very familiar source of problems in traceability and accountability in complex global supply chains (which the COVID-19 pandemic has brutally exposed as fragile, vulnerable and short on resilience), commensurate benefits from eliminating avoidable leakages and losses caused by user error are also firmly in evidence.

78. The "smart" aspect of the smart contract, while grounded in the automated and irreversible nature of the execution of agreed contract terms, is likely to develop rapidly as machine learning or forms of artificial intelligence begin to be applied to more strategic aspects of managing the flows of molecules and monies using the tagging techniques available.

79. An obvious way to achieve this within the context of good governance will be to reverse engineer a traceability and transparency algorithm that works its way back from the various value-add or even endpoints of a resource's lifecycle based on normalized reference models of how such resources have to behave according to their inherent materials attributes and known processing technologies, such that inexplicable aberrations from these models are flagged for review or investigation.

C. 3D Blockchain Model

80. The following is our circular model built during a proof-of-concept work on the applicability of blockchain to the UNRMS circular economy system. It was also clear that blockchain could be used for linear economy resource tracking, e.g. end-to-end lifecycle management, but industry trends drive development and uptake towards circularity and sustainability. The benefits of tracking ESG investment performance overall, including key performance indicators, were readily apparent.

81. The conceptual analysis was modelled against (a) notional specifications for various tools included in UNRMS and (b) existing systems (such as the different food supply-chain and customer service business line tools). The Structure of an inter-industry supply chain process with a Blockchain-Based Foundation to track, record, translate, and potentially communicate crucial data points and analytics to all relevant parties was elucidated. The workflow is modelled in Figure IV.

D. Advantages of Circular Blockchain Model

82. Transforming industry supply chains from the conventional linear model to the more sustainable and potentially more lucrative circular, blockchain-based model concerns all significant industries. The transformation leads the industries, like the resource management approach, to directly to an eco-system model of sustainable development. This point is made in the second concept paper (2020):

> *"If the objectives of the 2030 Agenda are to be achieved in time, and at a reasonable cost, then there has to be a change in the fundamental principles we use to manage resources. The core principles also need to be associative. They should connect to all sectors of development and the ecosystem by weaving a network of activities that lead to beneficial outcomes for people, planet and prosperity. The links of resource management should always be underpinned by the Food-Water-Energy (FEW) nexus."*

83. To encourage such industries to subscribe to the new way of thinking, some of its immediate advantages for circularity may be listed as follows:

- By tokenizing resources to underpin a more resource-efficient, sustainable supply chain model, which provides an opportunity for a more cost-effective method of production, transportation, and sale of goods or services but equally shares

responsibilities for resource use efficiency with consumers who are incented to adopt new values and behaviours

- A closed-loop model, where the circular economy promises an environmentally conscious and protective pathway for business transactions with a negative effect on revenue. Materials hitherto defined by the industries as "wastes" ("costs of doing business in a linear model") are rebranded and reclassified as reusable secondary raw materials
- It is the ability to track all statistics and data from every point of the supply chain. Thus, a data analysis algorithm / artificial intelligence can be designed to generate accurate, real-time visualization of vast data fields. Organizations can see the weak points in their supply chains with a simple programme to receive constant, time-accurate analysis.

84. The fit between blockchain technology and circular economy is very tight, and business adoption is already underway as well summarized in an October 2021 Opinion Page by PA Consulting:[25]

> *"One part of making the Circular Economy successful is incentivizing new behaviours, like sustainable resource production and consumption, product repurposing and recycling. Another part is assuring that the repurposed or recycled goods people and organizations buy aren't made from virgin materials. Without that trust and transparency, we're likely to revert to our current linear economy."*

85. These generic comments fit very closely with some of the core preoccupations of the Policy Brief, notably to restore trust and transparency. In contrast, the emphasis on "incentivizing new behaviours" fits very well with the precepts of FeedUp to eliminate avoidable food waste. However, it caused these FeedUp precepts (resource use efficiency and value preservation, beneficial behavioural modification) that apply equally across the whole resource nexus not just to food.

E. Advantages and Disadvantages of Blockchain Models

86. Advantages of blockchain include:

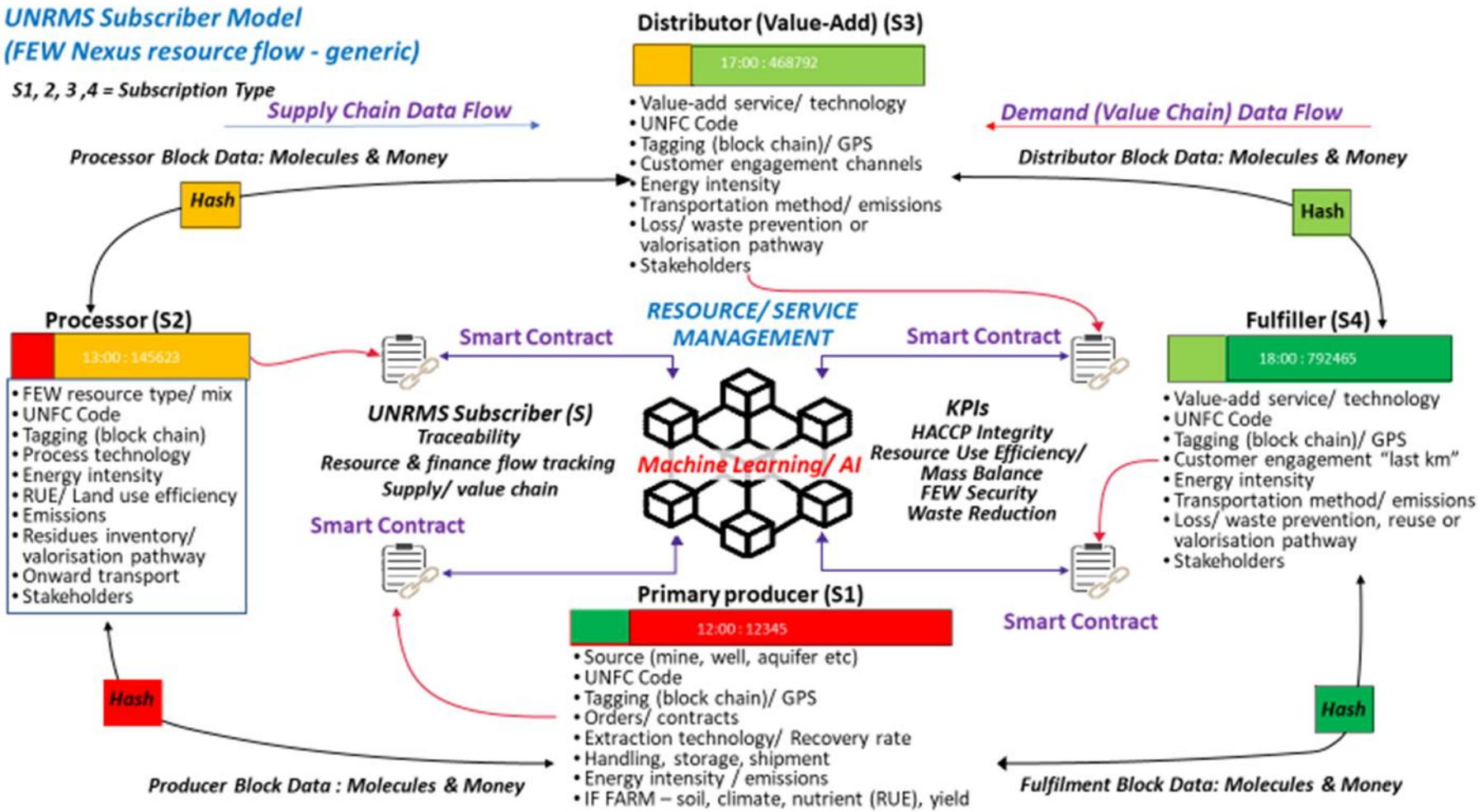
- Decentralized, immutable, distributed digital ledger
- Transparency of transactions and movement within a blockchain
- Can process single resources, combinations of resources or complete resource nexuses (whole eco-system)
- Traceability is in-built and very hard to corrupt or falsify
- Record may not be tampered with retroactively without tampering with all subsequent blocks in the chain
- No need for third-party authorization on any transactions
- Uses Smart Contracts allowing for automatic verification of input data before execution
    - Requires no intermediary allowing for transparency
    - No time loss
- Can be used in any resource sector
    - The implementation of the model can simply be changed via programming
    - Promotes sustainable resource "eco-system" thinking and behaviours.

87. Disadvantages of blockchain include:

- Lack of standards (at least to date)
- User unfamiliarity
- Some systems have high energy costs, thus still some distance from "climate-smart".

[25] See Mark Lancelott, Nic Chrysochou, Patrick Archard, PA Opinion, PA Consulting https://www.paconsulting.com/insights/blockchain-can-drive-the-circular-economy/

Figure IV
Circular Depiction of Blockchain Subscription Model by Stakeholder Type



VI. Conclusions and recommendations

88. This concept note provides the arguments for progressing towards a sustainable, integrated and more circular economy utilizing systems thinking. Sustainability and integration of resource management need to align to the food-water-energy nexus. Moving towards a more circular world will be the essential decoupling of resources and development. There is a need to move away from an exclusive focus on resources as commodities to the desired social and economic outcomes achieved by managing them differently, in an integrated, systemic way.

89. As noted in this Concept Note (Section V.B, para 74), there is compelling evidence of the quantifiable benefits assessment of a range of blockchain systems now in commercial use. These include making the value of resources more apparent, facilitating a new system of pricing and trading natural resources, preserving and enhancing value through the resource life cycles, and incentivizing people to adopt circular behaviours. So, the flows of monies and molecules converge in blockchain, in the process offering a systemic, "Resource as a Service" solution to resolving many of the more egregious weaknesses and unwanted negative externalities of the linear socio-economic model of resource management. By assigning to a blockchain, "smart contract" system the task of tagging and tracking the resource flows, which people are typically not very good at, the capabilities of the people can be reassigned to the higher value parts of the managing resources in the circular economy, such as the pursuit of benefits to the environment, to society, and good governance.

90. Specifically, this Concept Note proposes three models that offer complementary ways of making good on the central proposition of the third Concept Paper,[26] to define the ethical and economic core of resource management as delivering a public good that can both drive the transition to and support the maintenance of the circular economy. These models may be summarized as:

(a) Resource as a Service: for meeting essential resource demands (critical needs) as a Service and a Public Good (Figure II);

(b) Resource Supply System: for securing resource supply, especially of materials critical either economically or socially or both, within an integrated resource nexus (Figure III);

(c) Blockchain and machine learning/ artificial intelligence model for resource management: by using blockchain tokenization for identifying and transparent and traceable flows of molecules and monies as non-fungible items through the circular resource economy, several key targets of the Policy Brief, such as inhibiting or eliminating illicit flows of both resources and funds,[27] can be met. By overlaying blockchain with machine learning and artificial intelligence to implement smart contracts in supply and value-chains supported by UNRMS system, the capacity to eliminate avoidable losses and wastages become "designed in" allowing much closer mapping of resource demand to resource supply - especially of critical raw materials - in a sustainable, financially transparent and fair manner (Figure IV).

91. The three models described above are not exhaustive. Still, they represent three core aspects of sustainable and integrated management of resources. When implemented, for example, in UNRMS, stakeholders have the prospect of gaining a secure, resilient and uninterrupted supply of tangible resources needed for sustainable development while achieving high impact, broadly shared tangible and intangible benefits to society and the environment from more stable and consistent resource management. This way, the equitable supply of resources could be ensured without jeopardizing the delicate environmental and

[26] See Redefining resource management as a public good: The UNRMS as a transition vehicle to the circular economy https://unece.org/sed/documents/2021/04/working-documents/redefining-resource-management-public-good-unrms-transition

[27] Recommendation 17 in UN Policy Brief "Transforming Extractive Industries for Sustainable Development", United Nations, New York, May 25, 2021 https://www.un.org/sites/un2.un.org/files/sg_policy_brief_extractives.pdf.

social balances that may otherwise be at risk while reducing the risk of conflicts over access to scarce or critical resources.

92. Governments can benefit from a less vulnerable economy through a greater security materials supply. The financial sector can benefit from new investment instruments such as Green Bonds and opportunities for ESG investments in high-growth circular economy start-ups, reducing short and longer-term risks by regaining stakeholder trust and confidence. Industry can likewise benefit from the reputational gains of reporting and tracking their alignment with the SDGs, resulting in the greater assurance of social acceptance. Communities can benefit from adopting "circular" behaviours whereby the transparency of resource management enabled by blockchain incentivizes the alignment of values such as resource use efficiency. It also reinforces the agreement on resources as a public good across the entire value chain.

93. The Sustainable Development Goals Delivery Working Group recommends developing the guidelines and best practices of these three models and including them in UNRMS as set out in Recommendation 15 of the UN Policy Brief.

94. Partnering with appropriate ECE entities and other organizations, including the UN Regional Economic Commissions, will be necessary to develop these models.

95. Grounding UNRMS in these models will also assure its alignment with UNFC as the classification framework while balancing consistent and coherent resource management practices globally with a high degree of adaptability and traceability to managing local and regional needs, and priorities within a single UN approved system.

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