Bottom-up Greenness (BuG) Concept Paper

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1. Green Finance (GF) has become a policy priority among many national authorities. It has also become an adopted practice for public institutions like NUS which released its Green Finance Framework in April 2020. Various businesses on GF value chains are also emerging. This proposal is predicated on a central idea of objectively measuring `greenness' of individuals (natural persons) and corporates (legal persons of small and large) in agricultural supply chains via bottom-up aggregation.

2. A business operation at any stage of a supply chain can be viewed as a collection of activity-weighted individuals and corporates by a bottom-up aggregation much like how one approaches an investment portfolio. In short, AIDF along with the partners intend to develop a **Bottom-up Greenness (BuG)** analytical platform to generate a **digital greenness credential (DGC)** for businesses, large and small, in agricultural supply chains through deploying modern IT and data analytics.

3. **BuG** is a platform to generate real-time activity-weighted greenness scores for any entities on an agricultural supply chain operated in the covered region. For example, consider an animal feed corn producer, labelled as Company A, taking in supplies from 100 farmers and 5 MSMEs in Kalimantan, Indonesia. The bottom-up aggregation concept underlying **BuG** is better illustrated by the attached diagram for this example. The Model assigns each of these 100 farmers a greenness score. The 5 MSMEs are five separate groups with each comprising likely different farmers also with greenness scores generated by the Model. Therefore, the greenness score for each MSME is simply a weighted score with an individual weight being a contributing farmer's supply quantity. Bottom-up aggregation to generate a **DGC** for Company A first takes place to the level for each of the 5 MSMEs before being further bottom-up aggregated along with 100 individual farmers/suppliers much like an investment fund being a fund of funds plus positions on individual stocks.

4. Four components are central to the feasibility of this proposal.

    a. First, we need to develop an on-the-ground measurement system, taking real-time readings of individual production entities (farmers and MSMEs). Thanks to the collaborative effort of two FinTech companies, iAPPS and CriAT[*], a prototype system utilizing internet of things (IOT) to take real-time readings of 200 plus farmers on over 40 defined attributes is already in operation in Kalimantan, Indonesia. In addition, they have already developed a preliminary greenness scoring system based on subjective weightings to assess these farmers.

[*] In the interest of full disclosure, Prof Duan is also a co-founder and the non-executive chairman of CriAT.

b. The second component rests on improving the quality and objectivity of the greenness score. We propose to invite NGOs of international repute specializing in green future to join as partners to offer independent assessments on a sample of individual farmers and MSMEs to enable `supervised learning' of a predictive model critical to production-level scaling up. In the language of modern data analytics, NGOs will provide to the training sample the arm's length `greenness labels' whereas the IOT system of iAPPS and CriAT offers 'features', i.e., attributes.

c. The third component hinges on research capabilities and analytical knowhow that are essential to developing the Model and the aggregation-related analytical infrastructure. AIDF with its Credit Research Initiative (CRI) team fits this role well. This team pioneered and has been maintaining the *public good* CRI (https://nuscri.org) infrastructure since 2009. A similar bottom-up aggregation idea has been previously implemented in a collaboration between the International Monetary Fund (IMF) and the CRI team in 2015. The BuDA (Bottom-up Default Analysis) toolkit is routinely deployed by IMF economists in their financial stability analyses.

d. The fourth component involves the commercial roll out of the greenness score which will require an entity with a strong global footprint in the banking sector to (1) incubate the design of agnostic sustainability financing schemes and (2) promote the greenness score through its client and industry networks. Where it meets the bank's credit risk appetite, the bank can roll out sustainability-linked loans leveraging the greenness score.

5. **BuG** confronts the operational reality that some suppliers may not have readily observable and verifiable data for computing their individual scores. The solution relies on the statistical concept of a sample vs the population. In short, one draws inferences on a population based upon a sample observed. Since a sample of this type is not totally random and likely reflects selection biases (natural or intentional), we intend to utilize the NGO's existing holistic greenness assessments of corporate entities to develop a mechanism for statistical bias corrections.

6. **BuG**'s operation hinges on a periodically recalibrated model (the Model) linking `greenness labels' to 'features' that enables production-level scaling up when the IOT system is extended to a wider coverage of farmers and MSMEs in Kalimantan and elsewhere in Indonesia. NGOs will be invited to conduct periodic audits on the predictive greenness scores generated by the Model. These audits function as arm's length checks and the audit results will in turn be utilized to recalibrate the Model to form a positive feedback loop.

7. Real-time updates to **DGCs** will occur either due to changes in features collected via the IOT inputs and/or a company's decision to tune its portfolio of suppliers. Again, the score will move up and down in a way resembling changes to the value of an equity portfolio,

reacting to its component stocks' price movements and/or the portfolio manager's decision to rebalance the portfolio.

8. **BuG** has numerous potential applications. Generically, two large categories of usage are quite clear – (a) conducting managerial what-if scenario analyses, and (b) forecasting a supply-chain's greenness changes resulting from external environmental factors beyond managerial control.

    a. What-if scenario analysis is made possible due to the nature of bottom-up aggregation. To continue the example in Item #3, Company A intends to increase its greenness score, say, from 6.5 to 8 in a scale of 1 to 10. Many options are open to the management, for example, replacing 1 of the 5 MSME suppliers. **BuG** can produce a predictive score for each contemplated option. Then, management is readily positioned to choose the most cost-effective solution among options that meet the goal of scoring 8.

    b. The greenness score of a supply-chain operation will respond to some features outside of managerial control; for example, an unfavourable regional weather condition can lead to a worsening score. **BuG** enables the forecasting of the greenness score for a supply chain through, for instance, weather forecasting. The weather factor differentially impacts the scores of individual suppliers and the aggregation effectively translates the weather impact to the overall greenness of the supply chain.

9. Beyond for-profit business operations, **BuG** can help NGOs generate evidence-based arguments/studies to advance their advocacy work; for example, produces a what-if greenness outcome in Kalimantan, Indonesia were a pollution tax on a certain type of pesticide introduced.

The Bottom-up Greenness (BuG) Concept Diagram