Applying Digital Technologies to Manage Climate Change

Presentation to PICMET
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Outline

1. GHG Types, Sources, and Impacts on the carbon cycle
2. GHGs – A Problem or an Opportunity?
3. The Way Forward - Synthetic Biology and Bio-Engineering
4. Critical Enablers – Genetics Data, Biological Tools and AI/ML
5. **A Big change - New AI/ML approaches lead to better, faster, cheaper and less risky bio-design, product development, scale up and optimization.**

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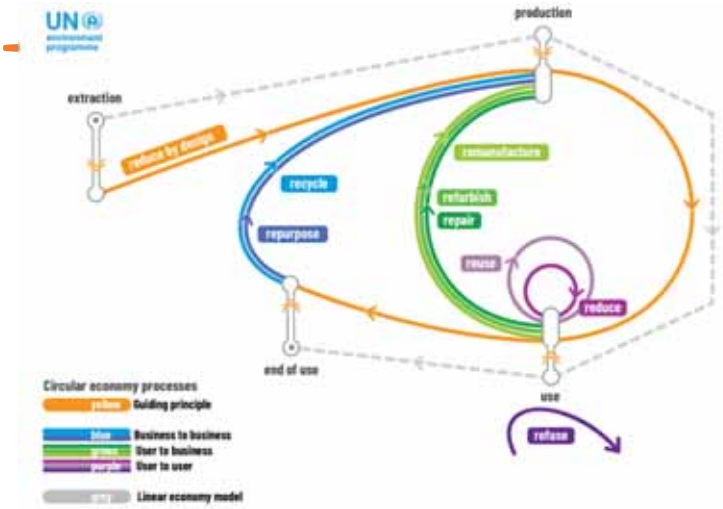
Circularity for Sustainability



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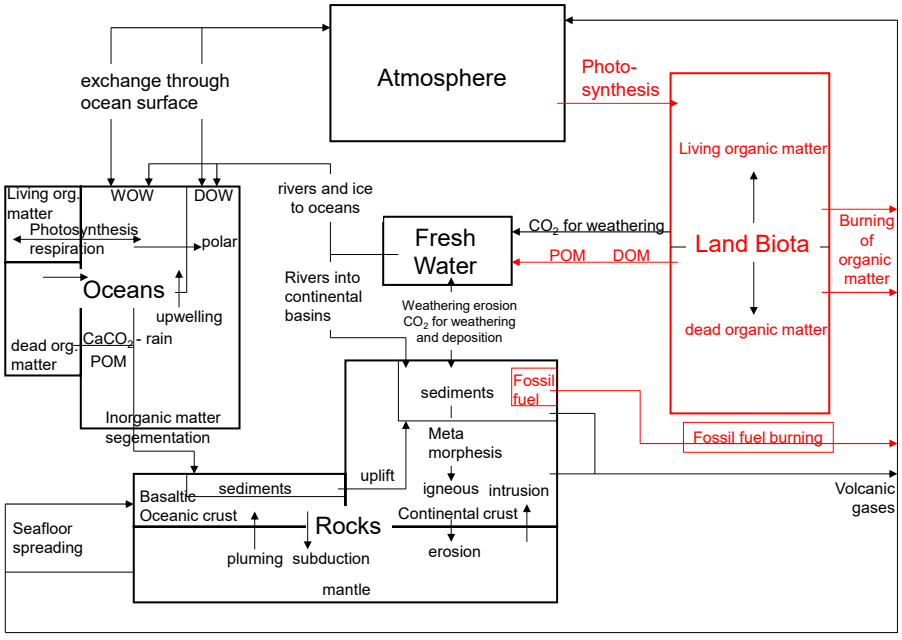
Carbon Cycle



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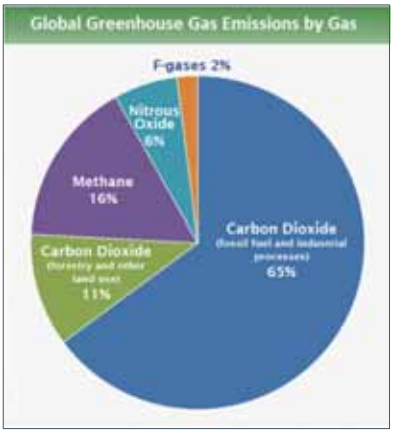
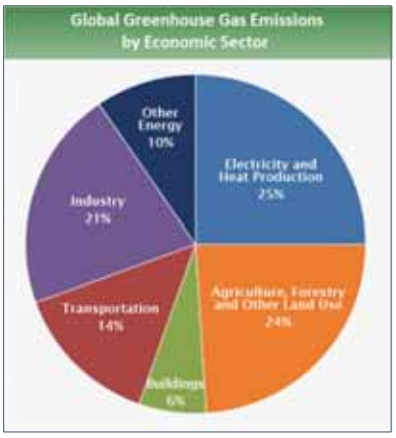
Man-made GHG Emissions



Major greenhouse gases
- CO_2
- Methane
- NO_2
- Fluorocarbons



Source: IPCC (2014): Bsed on global emissions from 2010. Details about the sources included in these estimates can be found in the *Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*.

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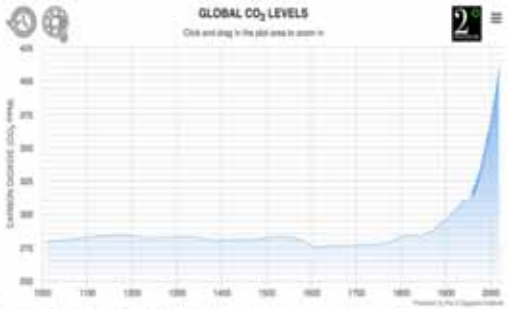
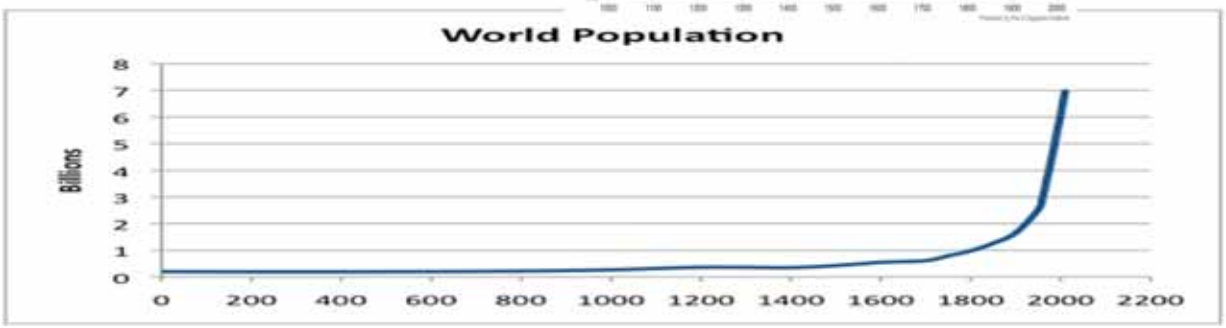
CO_2 and Population





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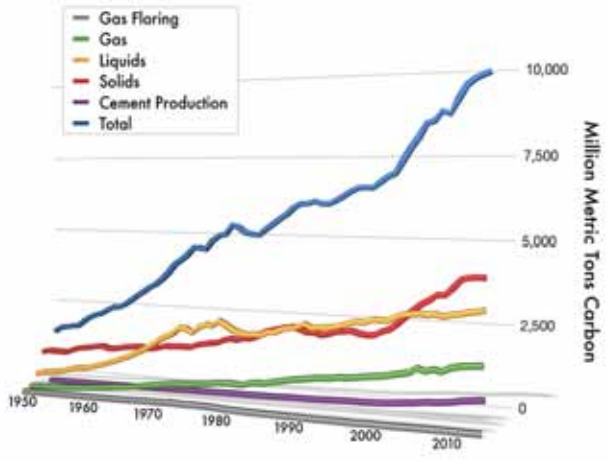
The Problem

- GHG reduction must be very large scale to make a significant difference – 1 billion tonnes/annum.
- Storage is not an economic solution
- It must require minimal incremental conventional energy.
- It must be low cost
- Something of value must be produced cost-effectively.



Global CO2 Emissions from Fossil-Fuel Burning

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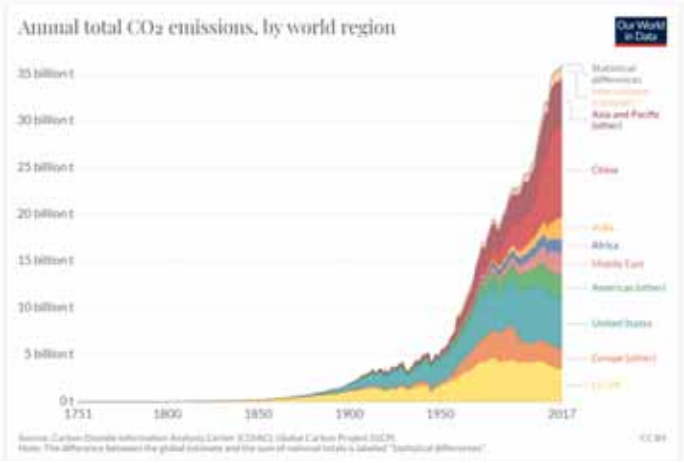
The Opportunity

G L O B A L
G H G
E M I S S I O N S
A R E A
M A S S I V E
U N T A P P E D
R E S O U R C E



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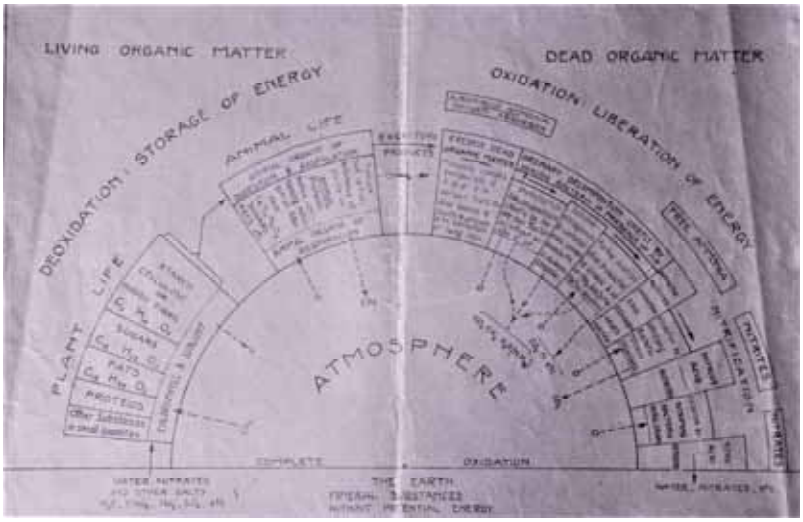
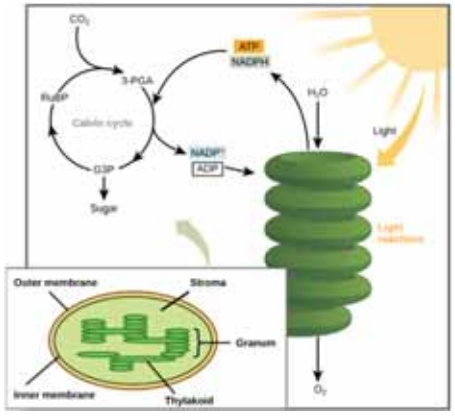
The Carbon Cycle is Overwhelmed

- The Rate of global Climate Change is accelerating
- Associated effects are becoming more severe.





This illustration shows that ATP and NADPH produced in the light reactions are used in the Calvin cycle to make sugar (Source: Khan Academy).

Nature spent billions of years developing pathways from CO2 and other gases to create forests, grasses, reefs and other products.

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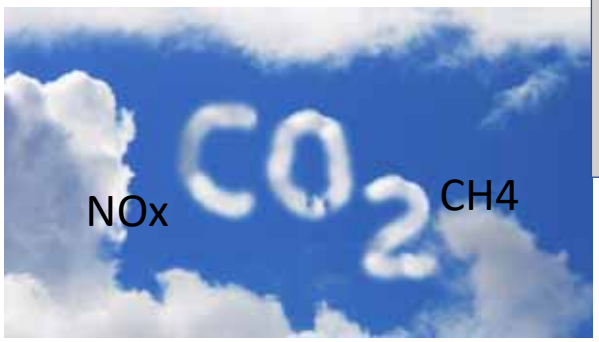
Now We Can Take Nature Several Steps Further



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We can build designer molecules to do our bidding and apply them to market needs and value chain application that exist around the world – like fuels, food, fertilizer, building products and advanced materials.

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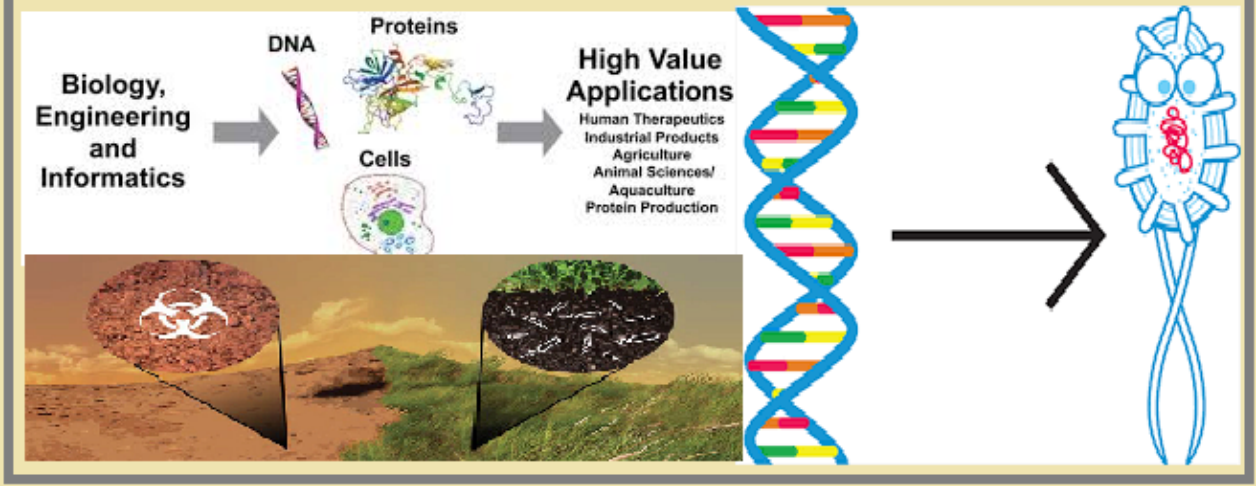
What is Synthetic Biology?



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2010 – 2020 The Second Decade of Synthetic Biology (Source Nature Communications)

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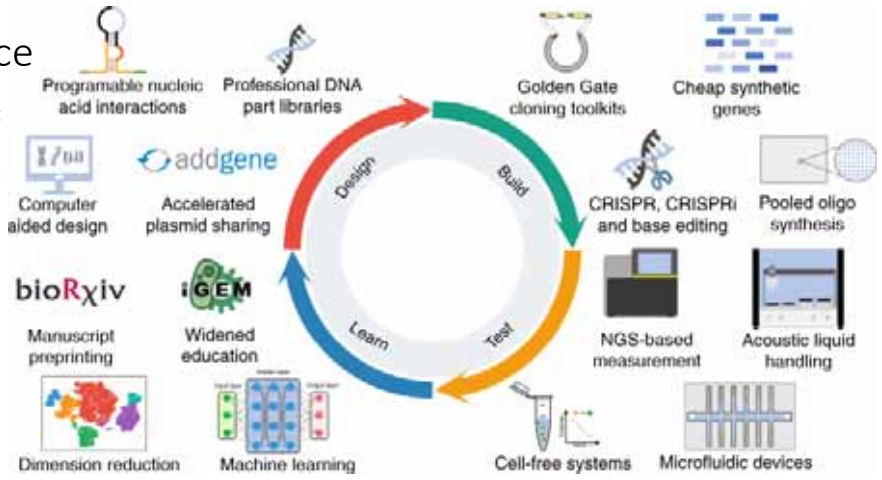
The Pieces are in Place

- Tools to make designer molecules:
  - Genetics
  - Alpha-folding prediction
  - CRISPr
  - Synthetic biology
  - AI & machine learning
- Market Needs and Applications:
  - Carbon reduction
  - Health
  - Waste Mitigation
  - Food/Nutrition
  - Materials



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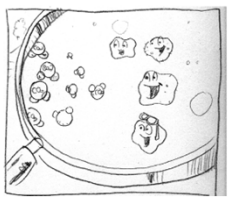
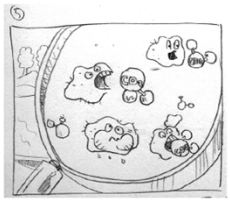
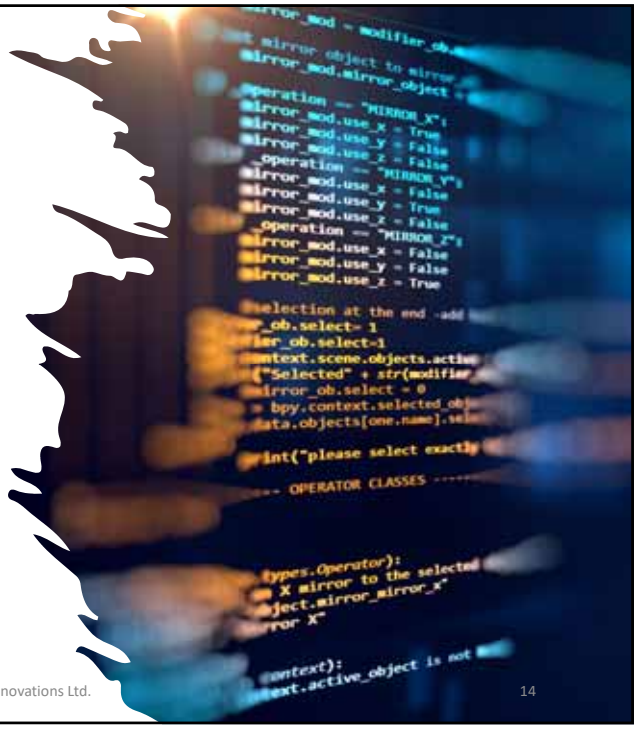




AI/ML Enabled Synthetic Biology to Address GHGs



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The BioDF Maximizer Platform

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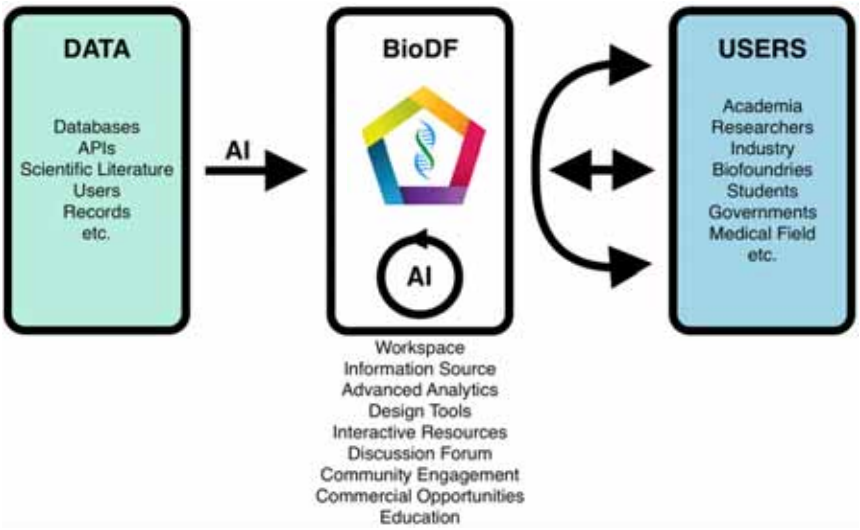

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SBB Pathway from Need to Value

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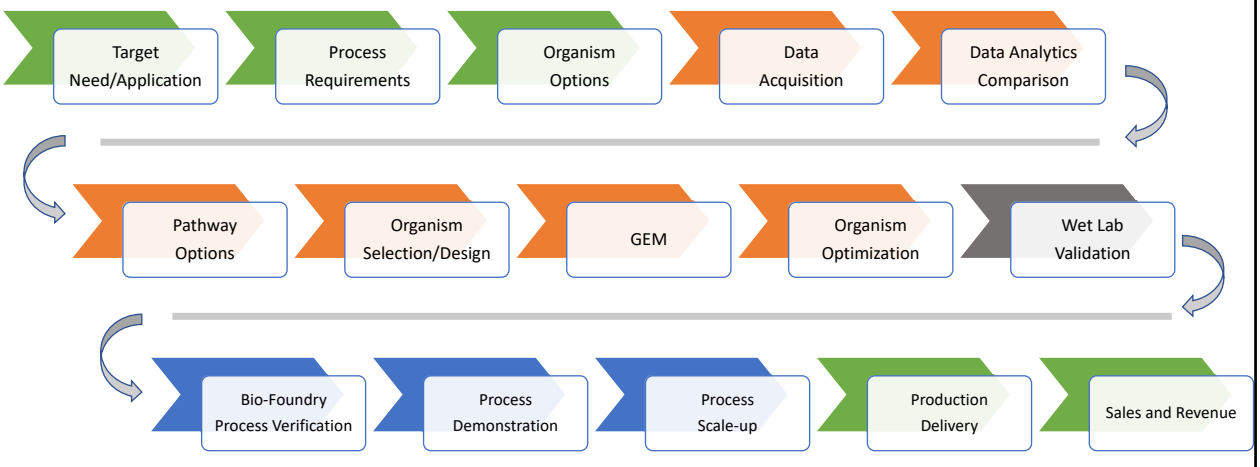

SBB Digital Pilot/Scale-Up

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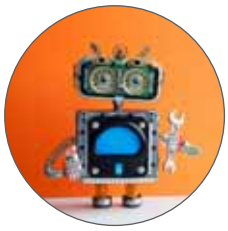
BioDF Overview

DATA COLLECTION

Automate the Indexing and collation of relevant datasets - from sequences to annotations into a master database.



AI POWERED TOOLS

Leverage AI tools in the areas of Natural Language Processing, Recommender and genome-wide Phylogenetic tree generation.

DIALOGUE FORUMS

A modern Internet discussion forum where researchers can openly discuss ideas and find inspiration.

WEB INTERFACE

A user interface for the rapid consultation of complex data, in a simplified format, for sophisticated analysis.

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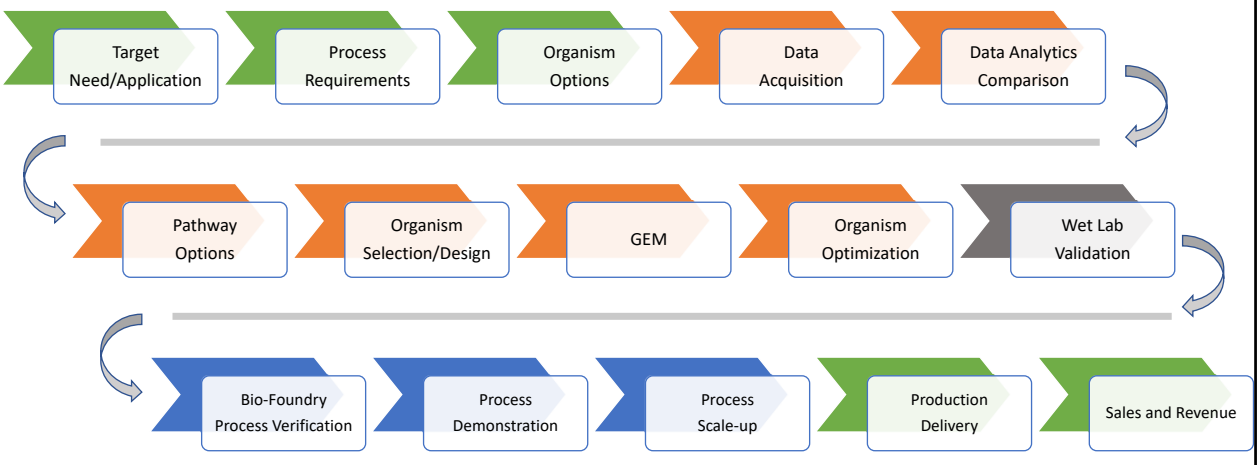
SBB Pathway from Need to Value



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For synthetic biology to become a mature engineering discipline, synthetic biologists require data and a toolkit specific to biology to design the parts that need to be put together and develop the methods for assembling them. AI and ML provide the capabilities Synbio players need to do that.

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Building pathways from waste to wealth

Reducing GHG emissions