

# Innovative Japanese Waste-to-Green Product Technologies: Economically Viable BECCS

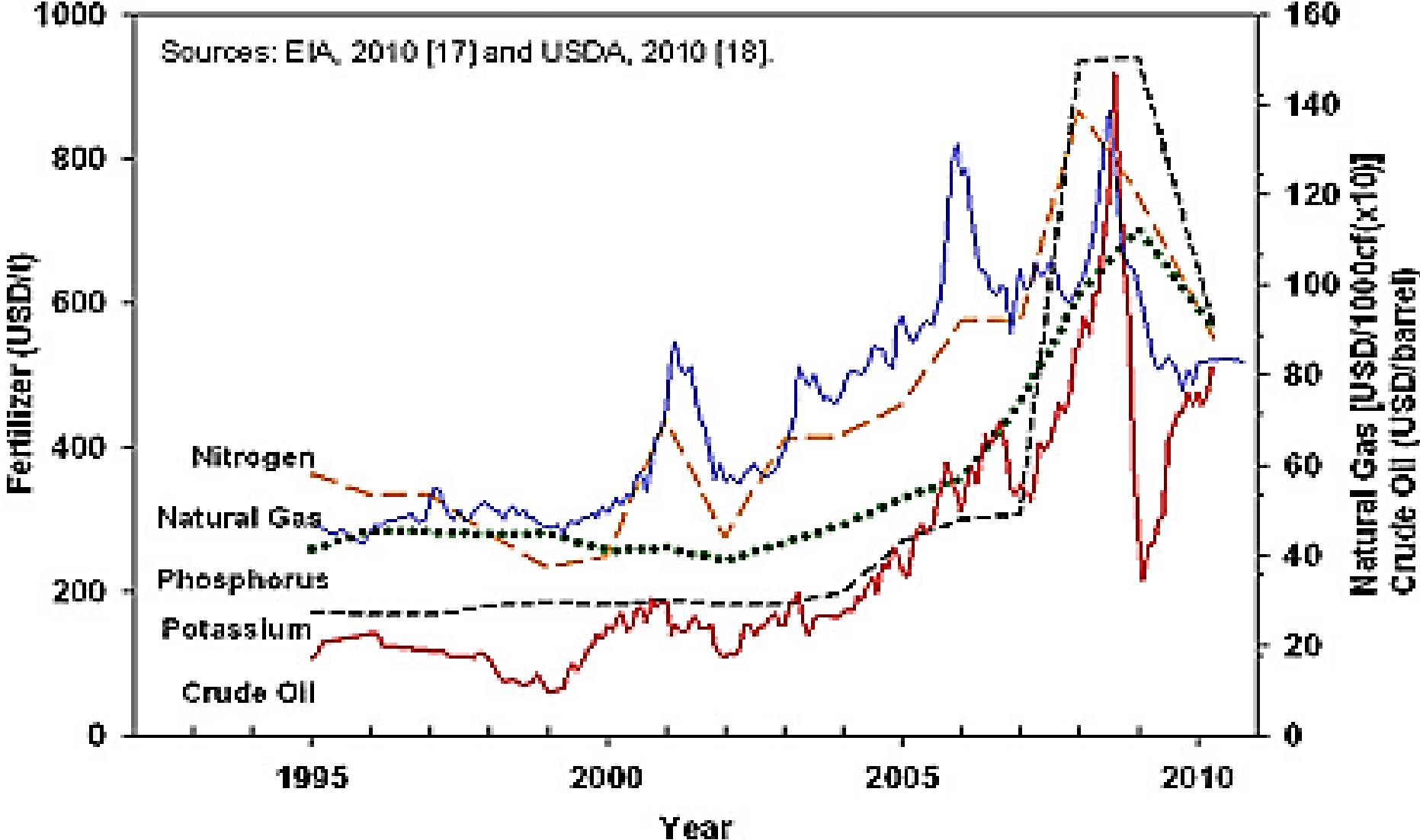
Kunio Yoshikawa

Professor

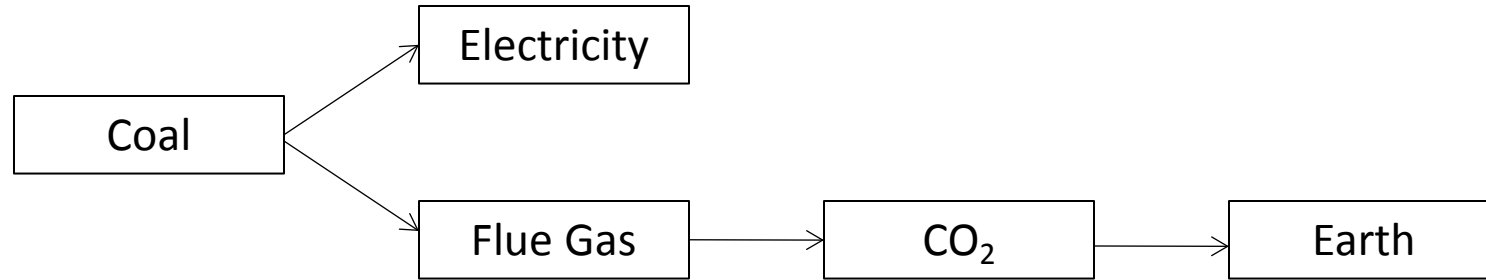
Tokyo Institute of Technology

Japan

# Oil and Fertilizer Price Change

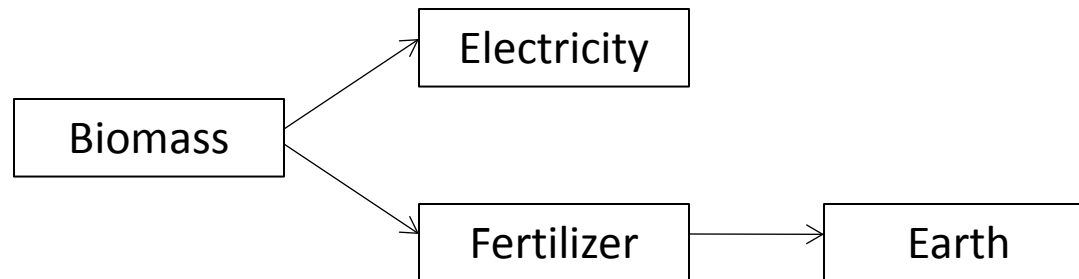


## Coal-CCS



(Without Economical Incentive)

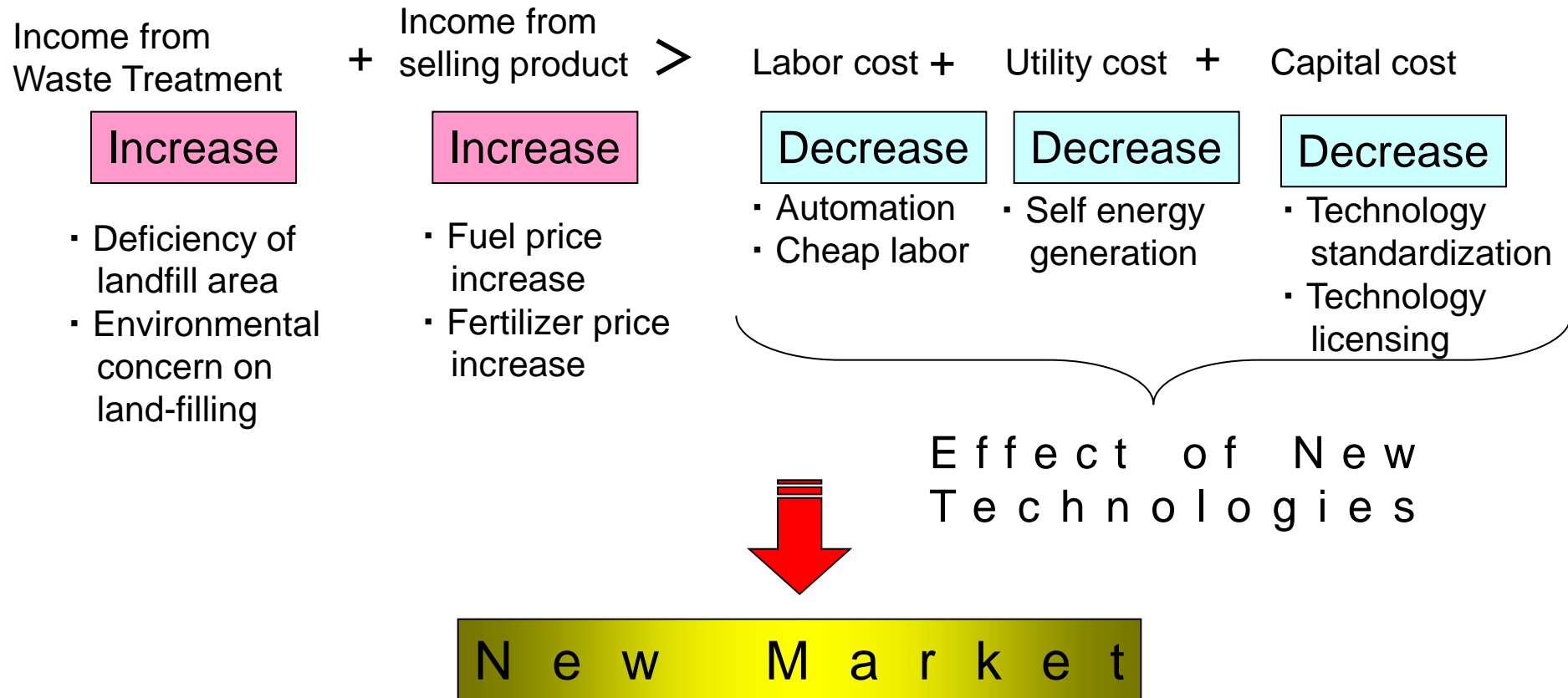
## Biomass-CCS



(With Economical Incentive)

# Economically Viable BECCS

# Condition for Profitable Waste-to-Green Product Business



# Resource Recycling System

## ① Waste-to-Coal Technology

MSW (Municipal Solid Waste), Hospital Waste

## ② Waste-to-Fertilizer Technology

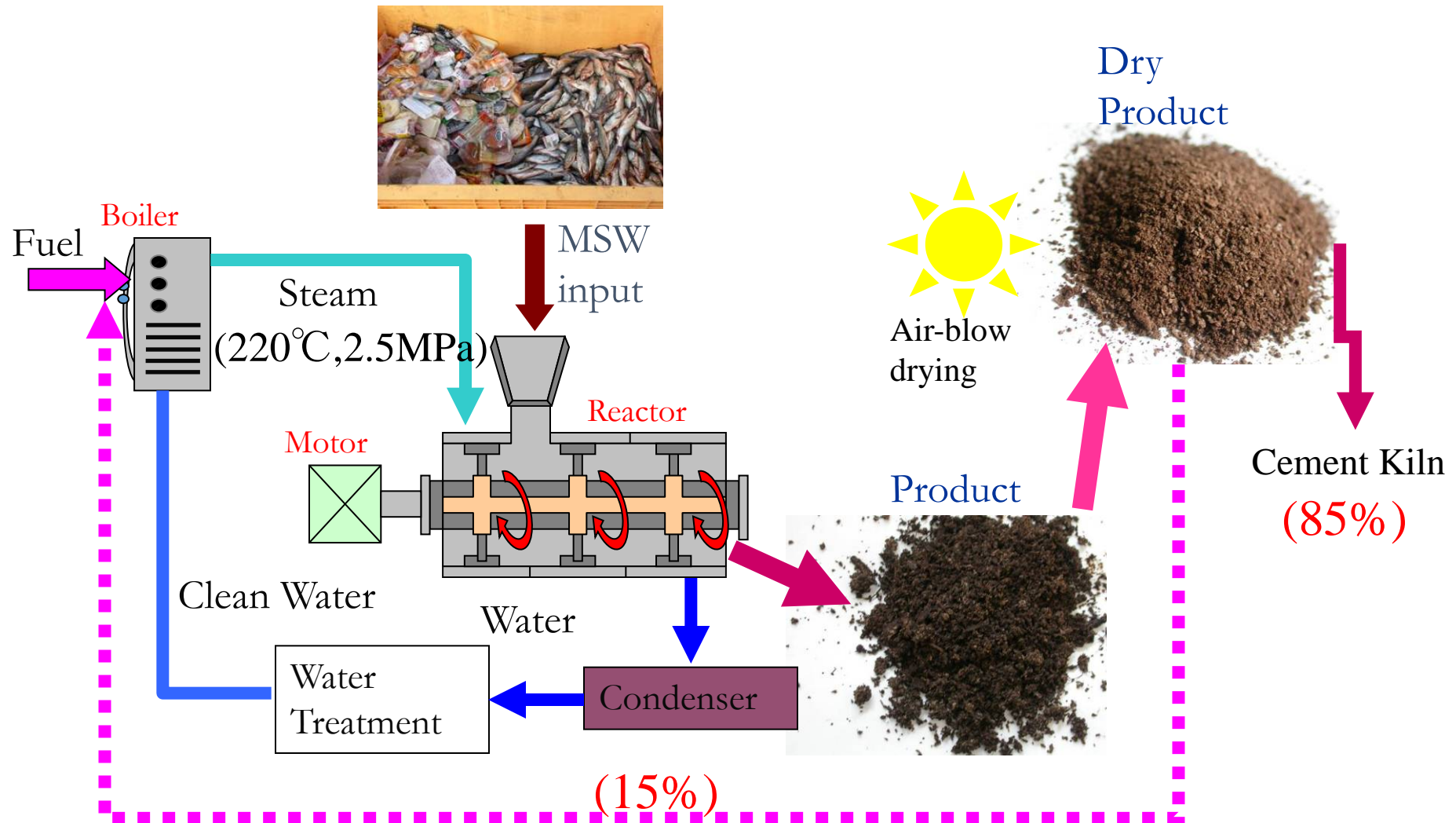
Sewage Sludge, Animal Manure, Food Waste

## ③ Waste-to-Electricity Technology

Biomass Wastes

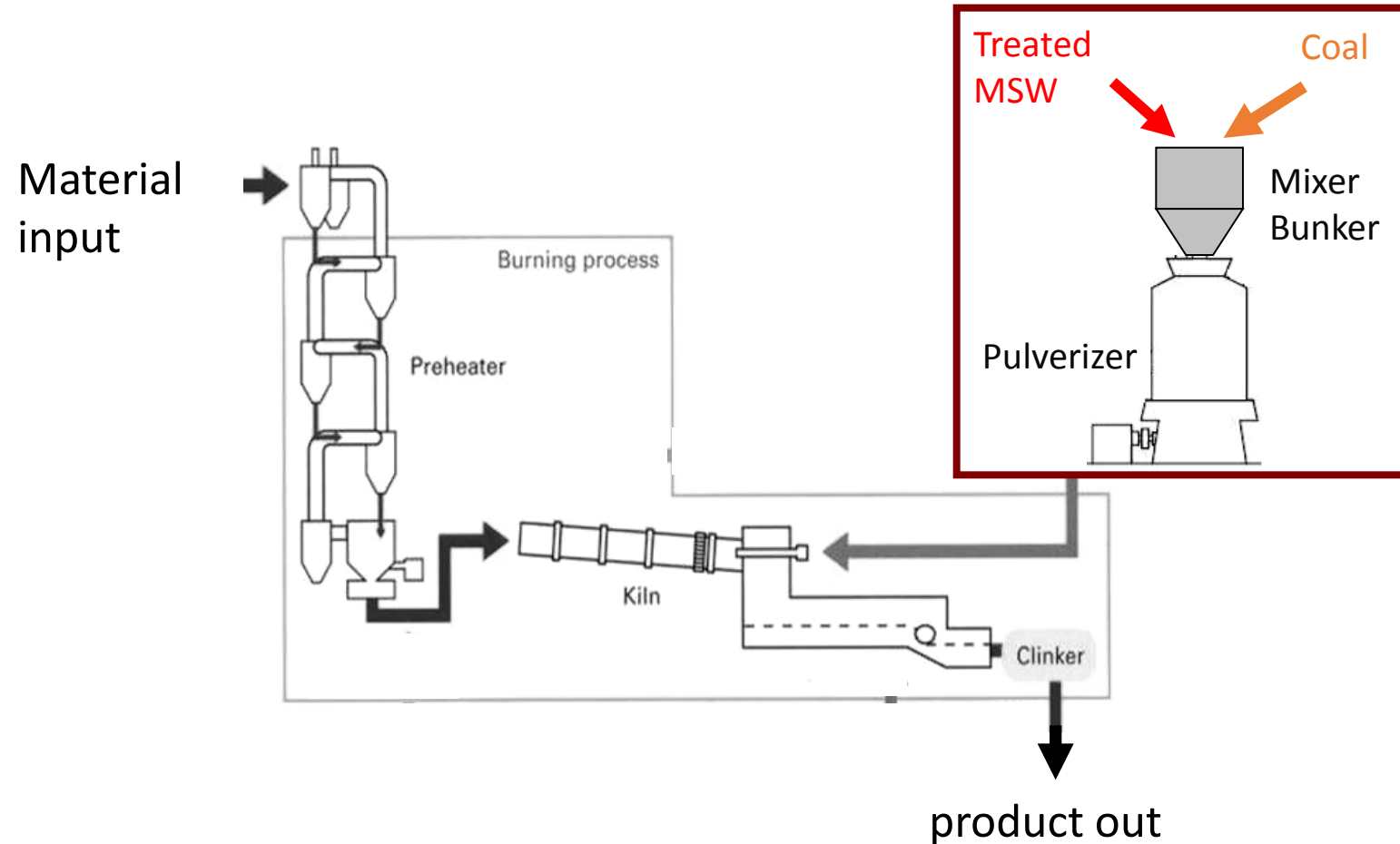
# ① Waste-to-Coal Technology

# Hydrothermal Treatment of MSW



# Application of Waste-to-Coal

In Cement Production Line



MSW = Municipal Solid Waste



# Commercial Plants



Hospital Wastes ( $3\text{m}^3$ )



Municipal Solid Wastes ( $12\text{m}^3$ )

# Profitability of Waste-to-Coal

- Treatment capacity of MSW : 100tons/day
- Investment for full treatment plant with 2 reactors – 3 M US\$.
- Moisture content of MSW : 65 %
- Production per annum on dry basis –12,600 tons/year (100tons/day X 0.35 X 360 days)
- Boiler fuel: 15% of RDF will be utilized as a boiler fuel – 1,890 tons/year
- Annual operation period: 360days
- Daily operation: 24 hours/day
- Maintenance cost/year (3% of the capital cost) – 0.09 M US\$/year
- VC and FC – (labor, electricity... ) – 0.06 M US\$/year
- Capital cost (5 years depreciation) – 0.6 M US\$/year
- Total expenditure – 0.75 M US\$/year
- Income by selling the product fuel – 1.61 M US\$/year (150 US\$/ton x (12,600-1,890)tons/year)

## **② Waste-to-Fertilizer Technology**

# Sewage sludge treatment



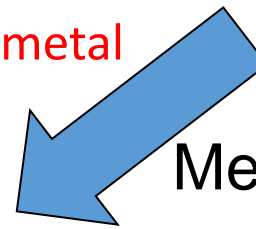
Water content 80%

Hydrothermal treatment

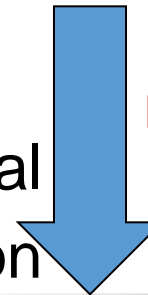


Water content 85%

Heavy metal



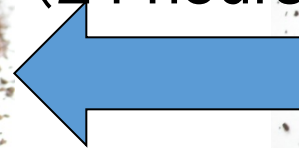
Mechanical dehydration



Nutrient (N, P, K)



Fast natural drying  
(24 hours)



Water content 55%



Separated water

Water content 10~20%



安全で安心なおいしい有機野菜をご提供いたします

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## 速効性の有機肥料 **有機バイオ**

粉体15kg袋詰



20L液肥



500ml液肥(一般家庭用)



※一般家庭用の500ml液肥は「[ワタミファーム倶楽部](#)」で販売しております。

500ml液肥(スプレー容器付)

¥1,800(送料込)

**36,000 US\$/ton**

「有機バイオ」は有機物を水熱反応(200度200気圧)で処理した肥料です。  
高温・高圧処理によって低分子化されたアミノ酸、オリゴ糖主体の肥料で、発酵タイプの肥料と比べて1/3量の使用で効果があります。

### 使用効果例

**速効性があります！**

低分子のアミノ酸とオリゴ糖が主成分のため、低温や曇天時に大きな効果が出ます。  
稲の試験では、1ヶ月で通常の稲に比べ根量が1.5倍となる結果が出ています。

粉体は全層施肥でなく、溝施肥、穴肥、通路肥として使用すると効果的です。

液肥は界面活性効果があり、葉面散布、灌水、水田などに使用すると、育苗及び肥大期に効果的です。



# Commercial Plants



Food Wastes (10m<sup>3</sup>)  
Japan



Sewage Sludge (7.8 m<sup>3</sup>)  
China

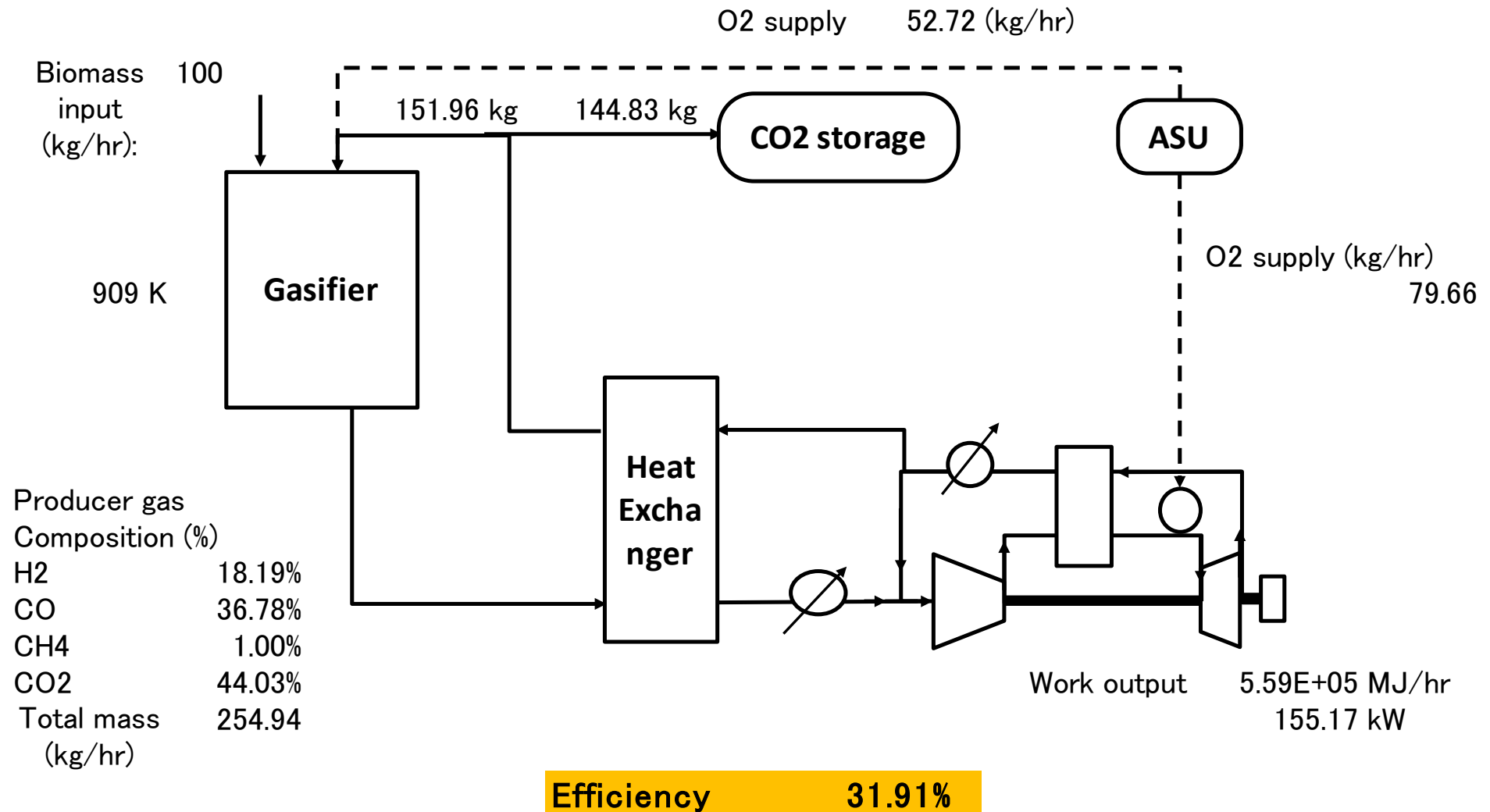
# Profitability of Waste-to-Fertilizer

- Treatment capacity of Sewage sludge : 30tons/day
- Investment for full treatment plant with 2 reactors – 1 M US\$
- Moisture content of sludge : 80 %
- Solid fuel production per annum on dry basis –2,160 tons/year (30tons/day X 0.2 X 360 days)
- Boiler fuel: 100% of RDF will be utilized as a boiler fuel – 2,160tons/year
- Liquid fertilizer production per annum –10,800tons/year (30tons/day X 360days)
- Annual operation period: 360days
- Daily operation: 24 hours/day
- Maintenance cost/year (3% of the capital cost) – 0.03 M US\$/year
- VC and FC – (labor, electricity... ) – 0.02 M US\$/year
- Capital cost (5 years depreciation) – 0.2 M US\$/year
- **Total expenditure – 0.25 M US\$/year**
- **Income by selling the liquid fertilizer – 2.16 M US\$/year** (200 US\$/ton x 10,800tons/year)

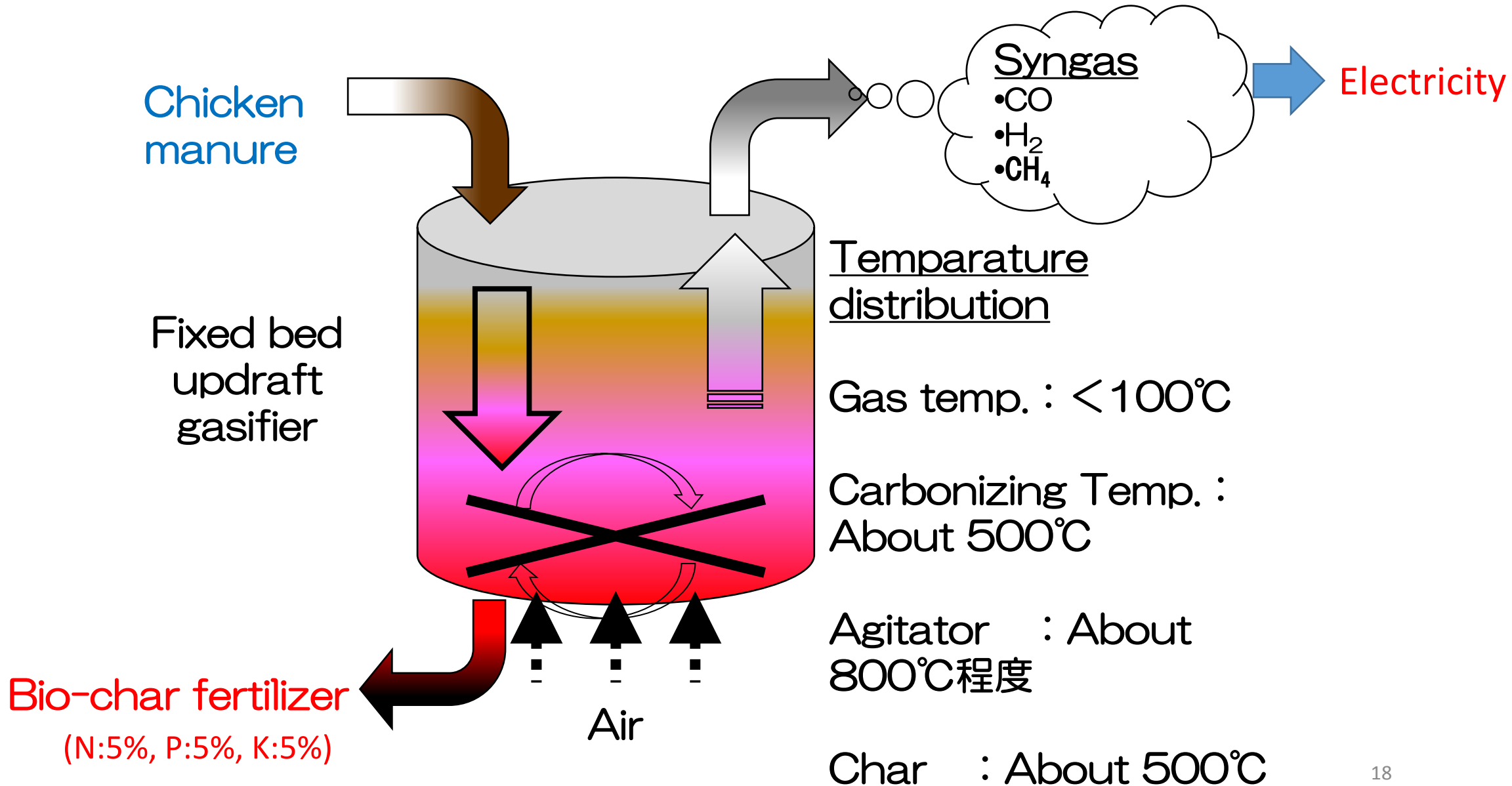
## **③ Waste-to-Electricity Technology**



# System analysis



# Outline of the carbonizer



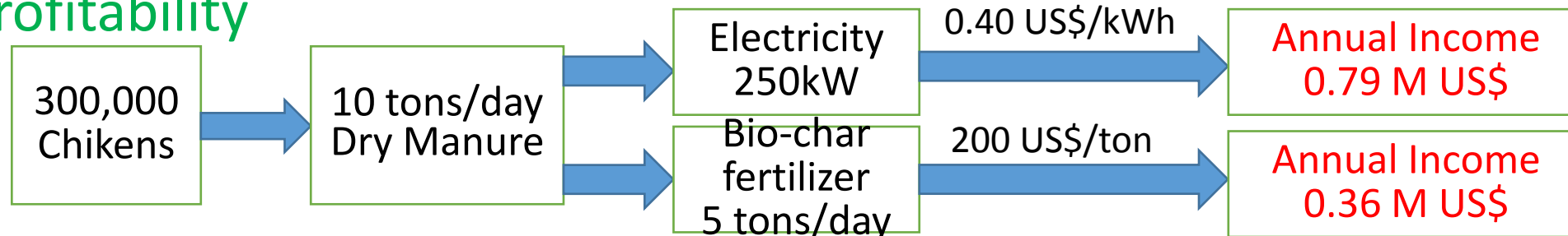
# Commercial Plant



Chicken Manure Dryer Unit  
Use of Chicken Body Heat  
and Excess Heat Energy  
(Water Content 70% → 15%)

Gasification Plant

## Profitability



Plant Cost: 1.5 M US\$