Realities, strategies & barriers in implementation of Green Chemistry

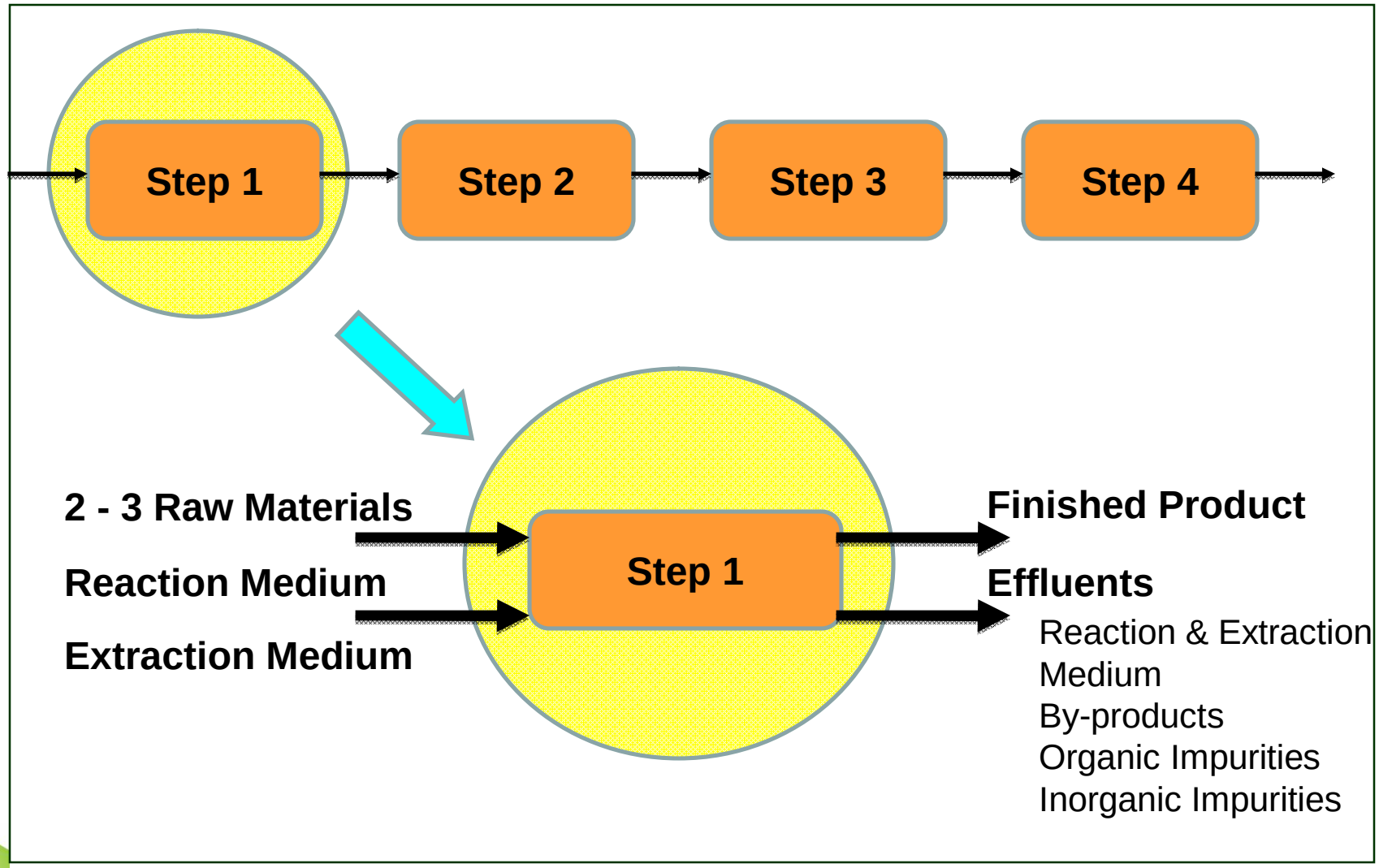
Nitesh H. Mehta
Founder Director
Newreka Green Synth Technologies Pvt. Ltd.
Mumbai, India
www.newreka.co.in

nitesh.mehta@newreka.co.in

Flow

- Reality of our processes
- Reality of our plants
- Reality of our effluent streams
- Strategies to address our environmental challenges
- Barriers to implement Green Chemistry
- Conclusions

Reality of our processes



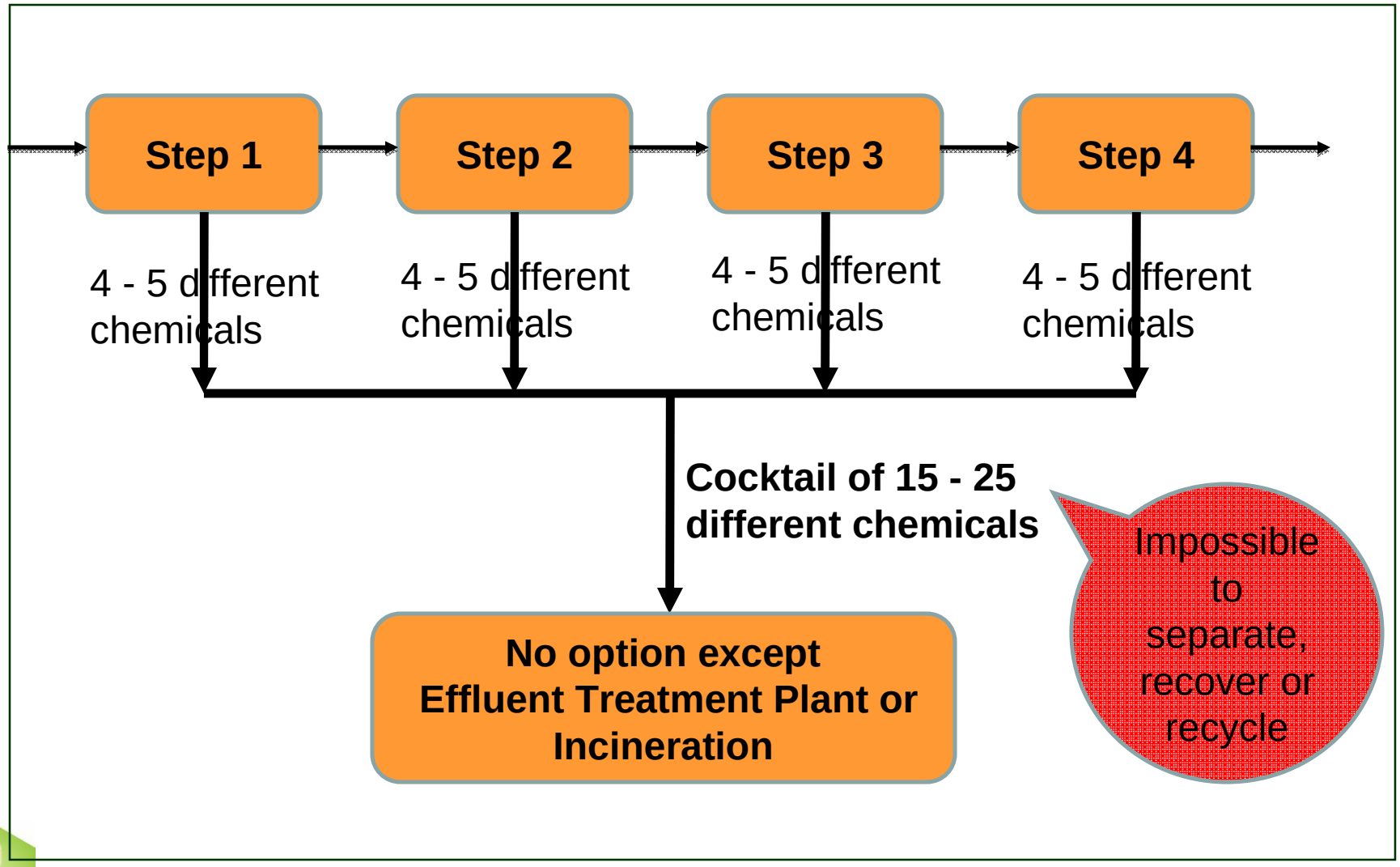
Reality of our processes

Nature of Pharma & Specialty Chemical manufacturing:

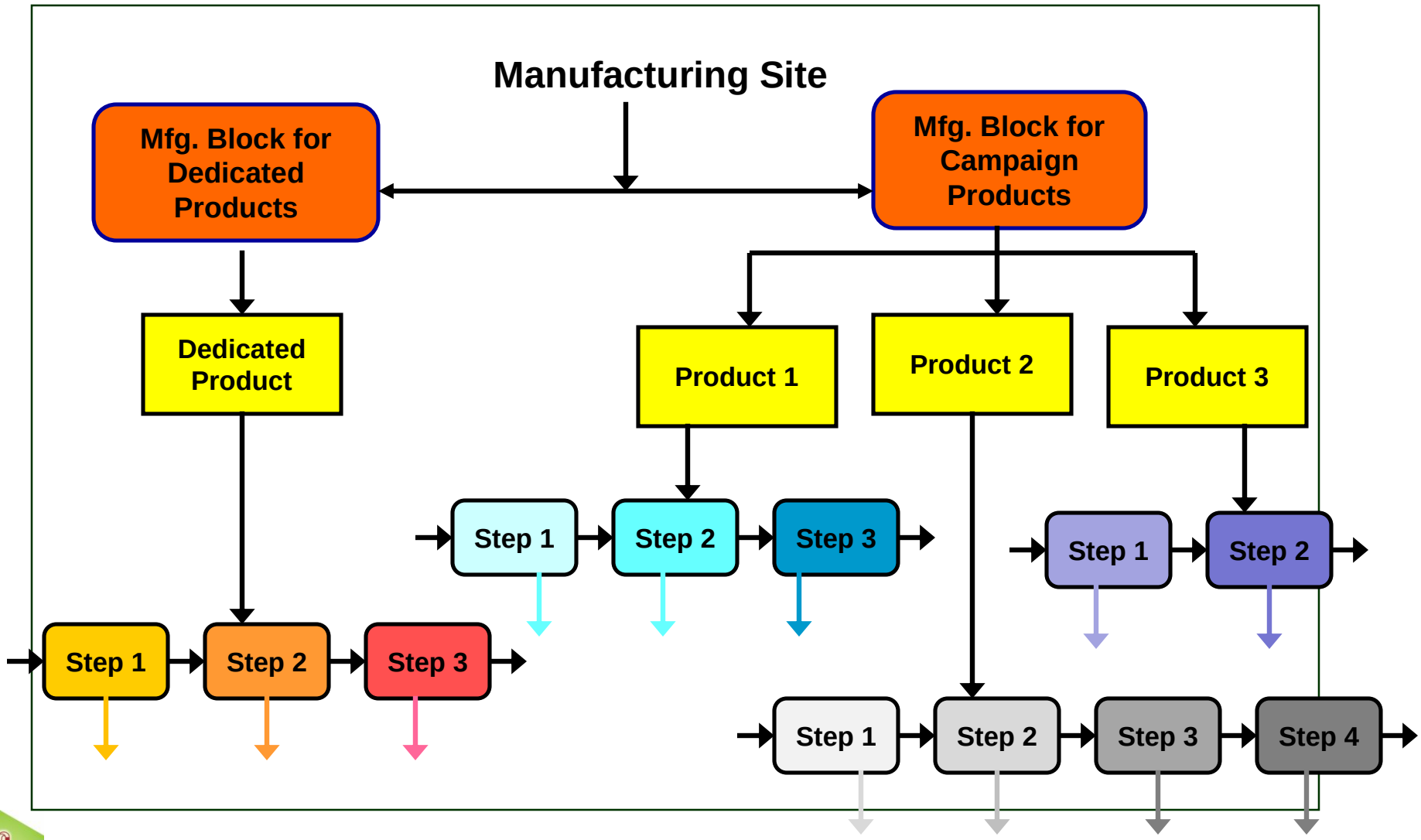
- Complex molecules & multi-step synthesis
- Chemistry Intensive processes
- Very low process yields (conversion, selectivity, separation efficiency – low)
- Stringent quality & regulatory requirements

The above leads to **High E - Factor or Environmental Impact Factor**

Reality of our processes



Reality of our plants

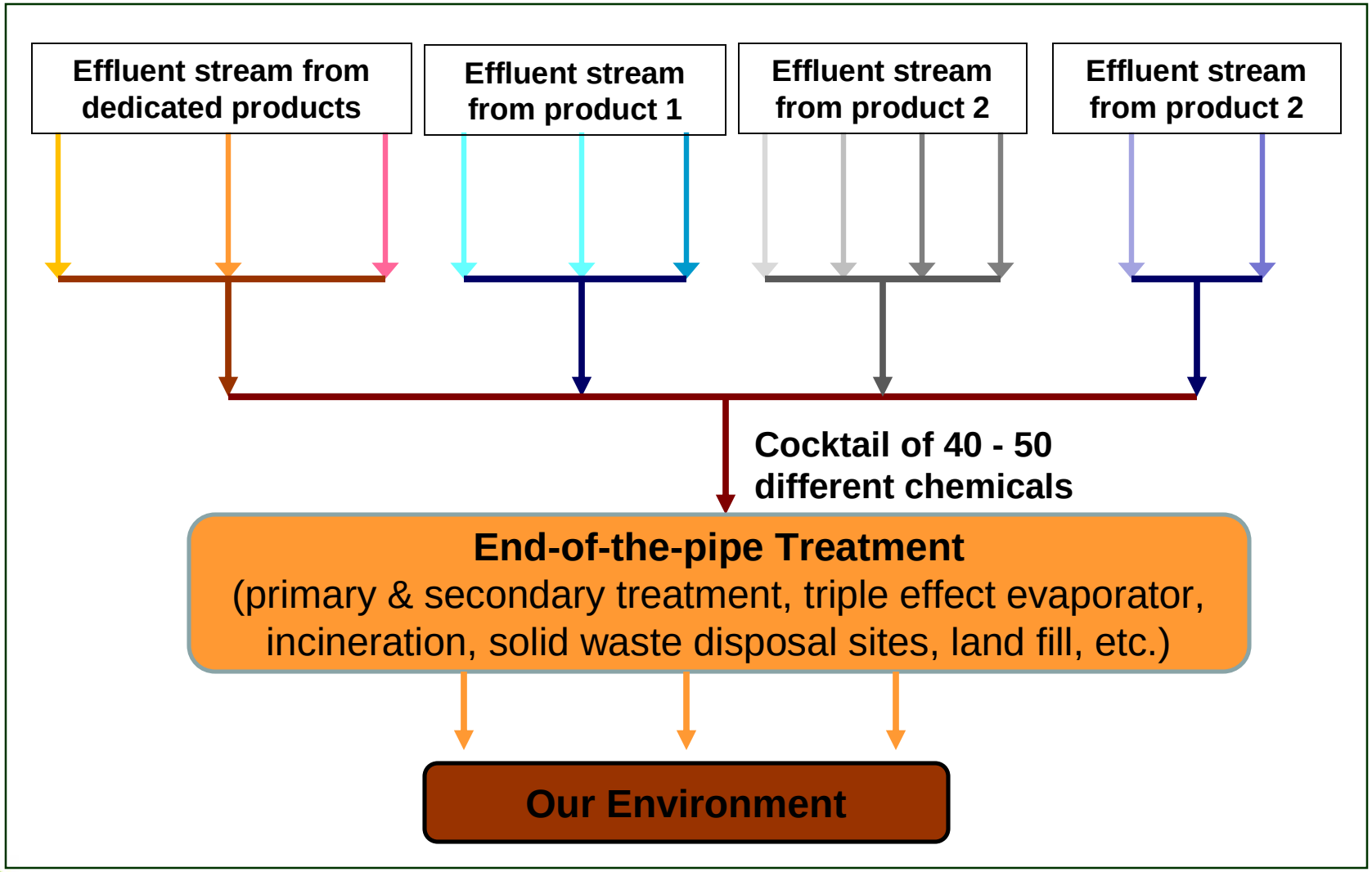


Reality of our effluent streams

- Each effluent stream has its own:
  - **Physical properties**
    - colour, pH, temperature
  - **Chemical composition**
    - organics, inorganics
  - **Volume**
  - **Characteristics**
    - COD, BOD, TDS, etc.
  - **Toxicity & hazard**

- What we have is:
  - multiple effluent streams with widely differing quantities & characteristics

Reality of our effluent streams



Reality of our effluent streams

Impact: huge threat to water bodies & human health

- **Quantity** : (e.g. approx. 1 bn kgs of API manufactured worldwide

  E-Factor = 25 to 100 + (ref: R. A. Sheldon)

  25 to 100 bn kgs per annum only from Pharma

  add to it that generated by dyes, pigments, agro, textiles, specialty & fine chemicals, etc…

- **Outcome** : converting one kind of effluent in to other
- **Toxicity** : not fully known (Ecotoxicity data available for less than 1% of human pharmaceuticals…Ref: journal "Regulatory Toxicology Pharmacology, April'2004)"
- **Degradation** : very slow, impact unknown after degradation
- **Direct Cost** : loss of solvent, utilities, raw material & finished product, treatment cost, higher overheads, losing business
- **Indirect Cost :** unreliable suppliers, credibility in market, anxiety, etc.

Strategies for implementation of GC

Where to start from? Basis of selection?

- Green Chemistry Metrices: may start with effluent stream with highest E-Factor, PMI, or any other matrices
  - Toxicity
  - Internal Competency
  - Cost pressures
  - Regulatory pressures
  - Demand from customer
  - Resources available
  - Management's priority
- Ready availability of a particular technology in market plae

Strategies for implementation of GC

Medium term

e.g. reinventing the way chemistry is done (e.g. greener catalyst)

Short term

e.g. Immediate, workable soln reduce effluent load like Recyle@Source™

Long term

e.g. Engineering aspects like micro reactors

Very Long term

e.g. designing new route of synthesis starting from renewable feedstock

Strategies for implementation of GC

Medium term

Time: 6months to 1.5 yrs
Resources : low to medium
Risk: low to medium

Short term

Time : 1 to 6 months
Resources: very low
Risk: very low

Long term

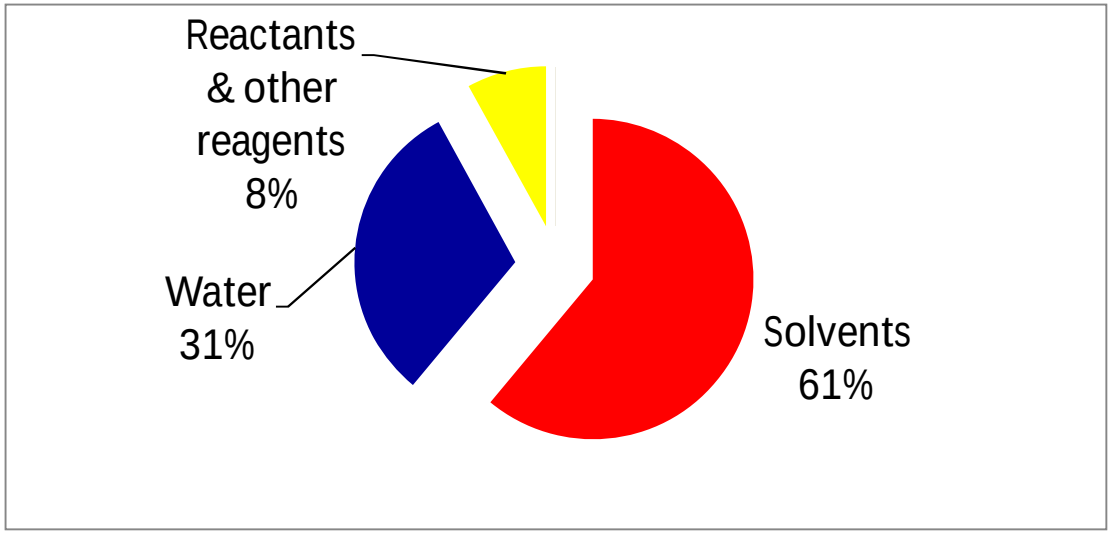
Time: 1.5 to 3 yrs
Resources: high
Risk: high

Very Long term

Time : 3 yrs to 10 years
Resources: very high
Risk: very high

Strategies for implementation of GC

Solvent & Water contribute more than 90% of the Reaction Mass

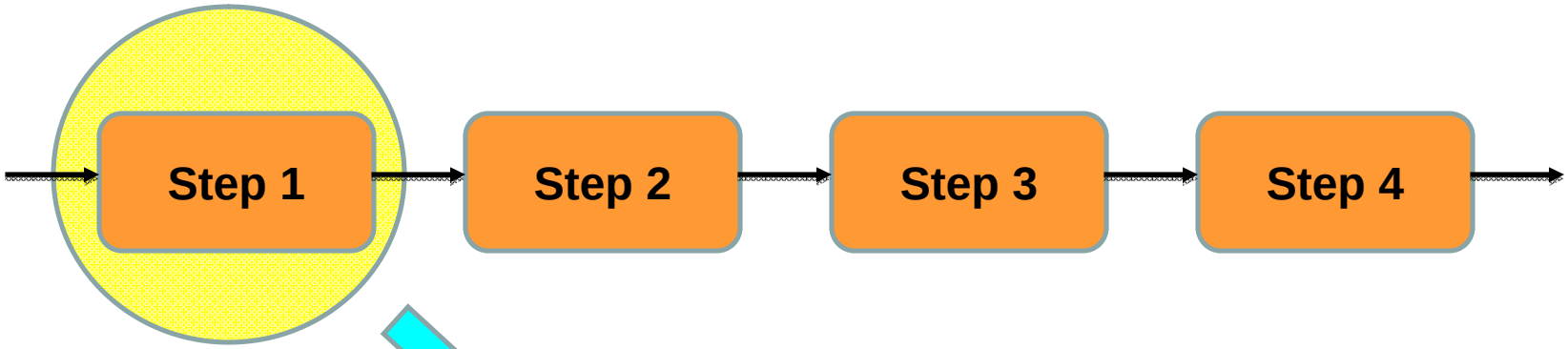


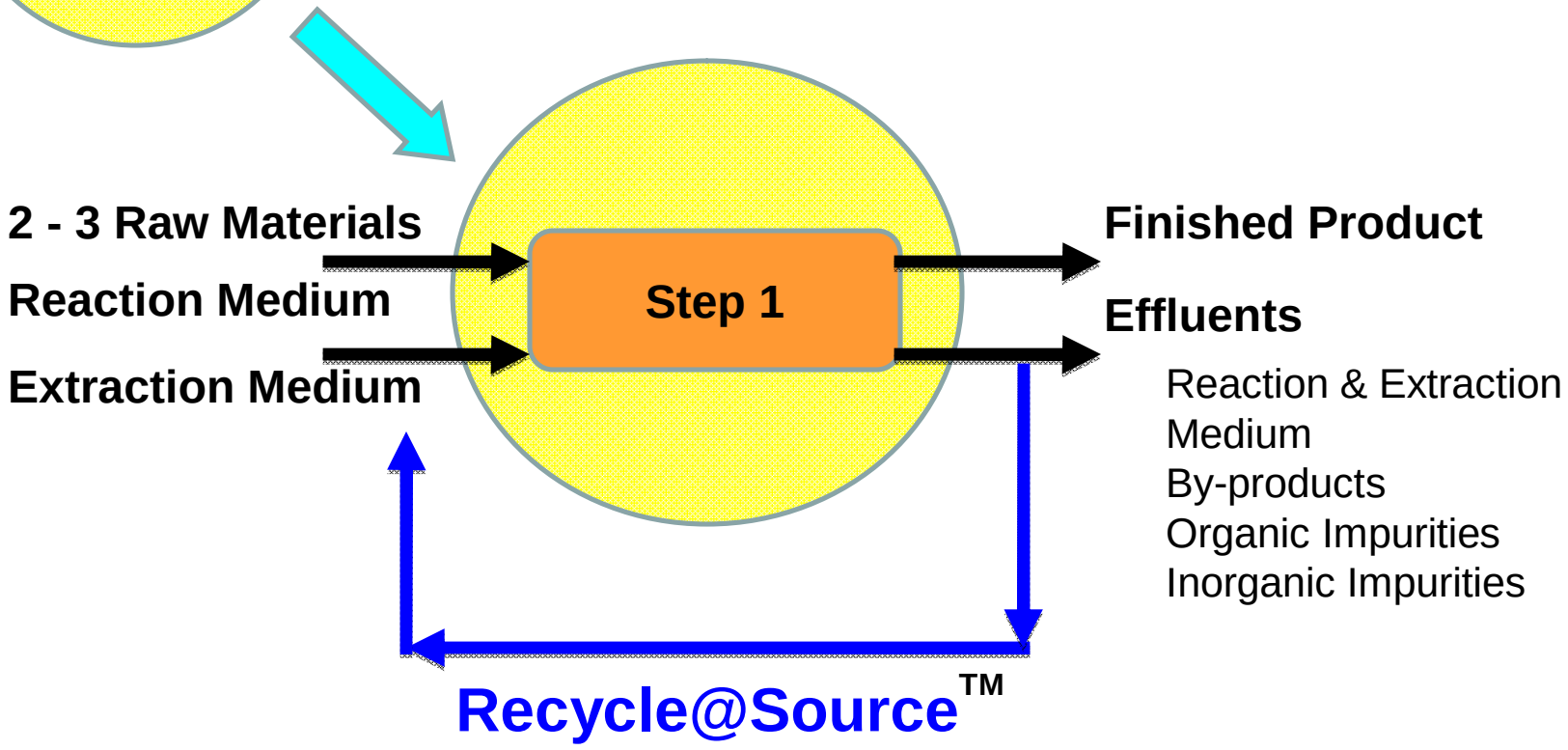
Source Data: ACS GCI Pharmaceutical Roundtable benchmarking exercise 2007

Most cases, average composition of Effluents will be close to composition of reaction & extraction medium.

Recycle of reaction & extraction medium can take care of 90% of effluent problems.

Short Term: e.g. Recycle@Source





Short Term: e.g. Recycle@Source™

Advantage of Recycle@Source™

- Short term, workable statregy which reduces effluent load
- Preventive approach vis-à-vis remedial approach
- Profit center based approach vis-à-vis cost center based approach
- Positively impacts triple bottom line of
    - People, Planet, Profit
- Enhanced yields, lower raw material consumption, lower E-Factor, lower effluent treatment costs, enhanced productivity
- Saving in time & efforts, other wise spent to deal with closure notices

Barriers to implementation of Green Chemistry

- Technical Barriers: no ecosystem for knowledge-based entrepreneurship
- Seed capital & funding barriers:
- IP Barriers: protecting IP
- Market Barriers: awareness, business model
- Human Barriers: Inertia to change, culture, language
- Scale-up Barriers: same result in lab as in plant, availability of plant, risk
- Barriers created by “Old Nexus”
- Regulatory Barriers: changes in DMF
- Financial Barriers: working capital for growth

Conclusions

- We have plants which are manufacturing multiple products & each product involves a multi-step process.
- Each process generates a different type of effluent stream, multiple effluent streams with widely differing quantities & characteristics
- Our molecules are complex, very less idea about their environmental consequences
- Start wherever you want to or can. **But let's START.**
- Create short term & long term strategy – to implement Green Chemistry & Green Engineering in to operations
- Shift from a cost centre approach to a profit-centric approach
- Environmental challenges are opportunities to make **PROFITS**.

Thank you