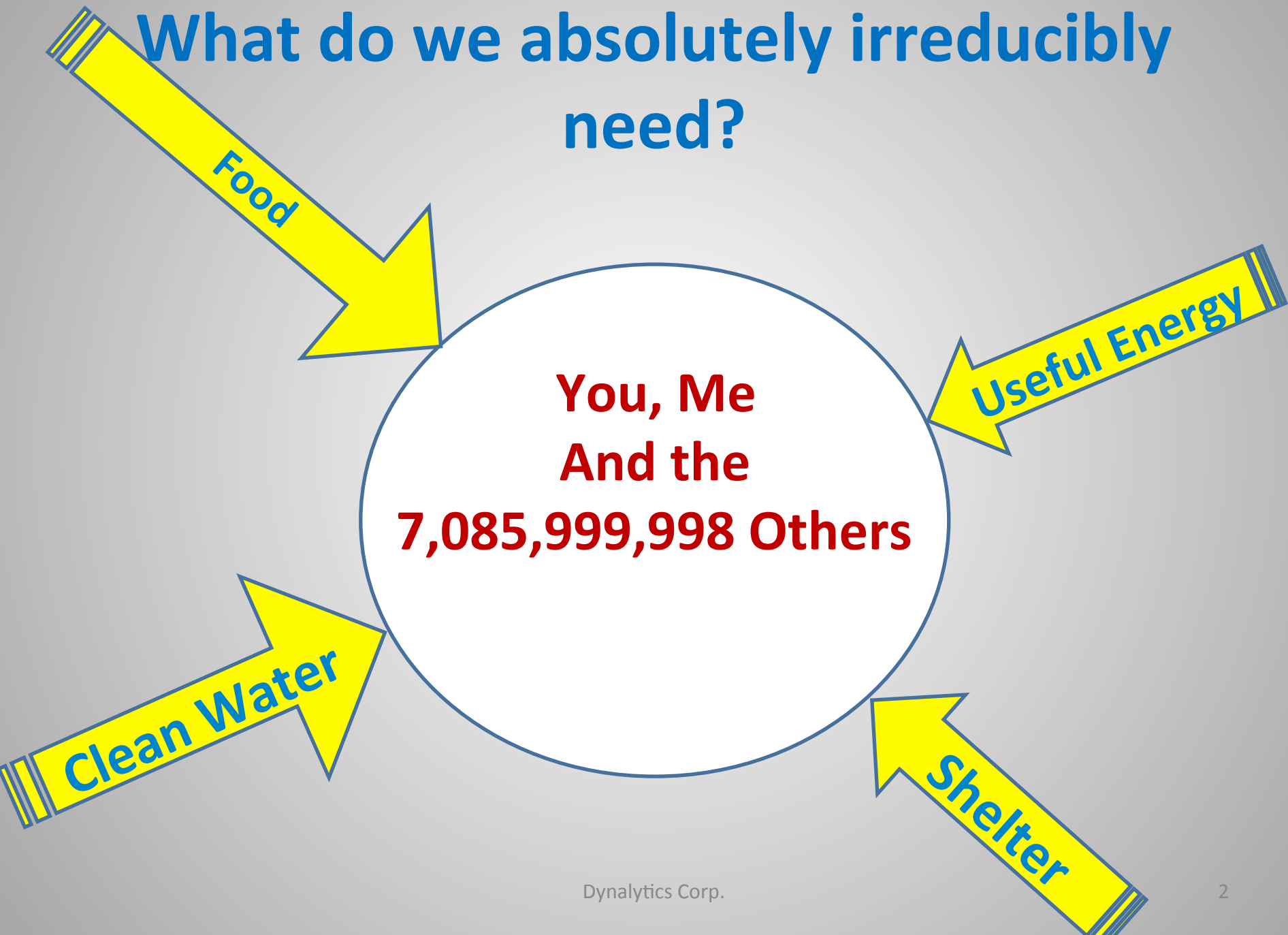


Climate Change
Opportunities
For
Chemical Engineers

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What do we absolutely irreducibly need?



What is not in dispute

We are experiencing:

- **Higher Air Temperatures**
- **Rapidly Melting Glaciers and Icebergs**
- **More Frequent and More Severe:**
 - *Floods, Droughts, Hurricanes, Storms, Tsunamis & Tropical Cyclones, Fires*
- **Changes in Crop Growing Seasons**
- **Increasing Atmospheric CO₂ Levels**

What May These Lead To?

Huge Disclaimer!

**All predictions are dangerous;
Especially those about the future!**

Higher Temperatures Will Lead To:

- **Increased Electric Demands**
- **More Air Conditioning; More Efficient Units**
- **Need to Redesign Processes & Equipment Based on Air-Cooled Heat Exchangers, Cooling Towers**
- **Lower Allowable Water Discharge Temperatures**
- **Increased Use of Corrosion-Resistant Alloys and Paints**
- **Increased Demand for Light-Weight Clothing**
- **Increased Regulatory Control of Emissions**

More Flooding Will Lead To:

- **Relocation of Populations and Industrial Facilities**
- **Need for Substantial Upgrading:**
 - *Process Plants, Storage Facilities, Transportation & Distribution Networks*
 - *Water Runoff Treatment Facilities*
 - *Prevention of Salt Water Intrusion*

More Droughts Will Lead To:

- **Relocation of Populations and Industrial Facilities**
- **Major Changes by Crop Producers**
- **Water “Wars”**
- **Need for Substantial Upgrading of Water Systems:**
 - *Sources, Treatment, Conservation, Storage, Transportation & Distribution Networks*

Changed Crop Growing Seasons Will Lead To:

- **Relocation of Populations and Industrial Facilities**
- **Rationalization of Crop Production**
 - **Crop Types, Farm Locations**
- **Need for Additional or Different Fertilizers (?)**
- **Need for Additional Water (?)**
- **Need for Additional or Different Pesticides (?)**
- **Water “Wars”**

More Fires Will Lead To:

- **Need for Substantial Upgrading:**
 - *Process Plants, Storage Facilities, Transportation & Distribution Networks*

What Will Actually Change?

- **How We Use Electricity and Fuels**
- **How We Produce and Distribute Electricity, Fuels and Other Products. We Will:**
 - *Use Less Energy-Intensive Raw Materials and Materials of Construction*
 - *Use More Efficient Processes and Equipment*
 - *Practice More Recovery of Byproducts*
 - *Practice More Recycling*
 - *Introduce Carbon Caps or Carbon Taxes*
- **Which, Where and How Crops are Produced**
 - *Use More/Less Irrigation*
 - *Use More/Less or Different Fertilizers*
 - *Use More/Less or Different Pesticides*

Chemical Engineering Career Paths

- **R & D (Academic, Industrial, Governmental)**
- **Process & Equipment Design**
- **Project Engineering**
- **Plant Operation**
- **Financial Sector:**
 - *Due Diligence (Debt & Equity Providers, M & A Projects, Insurance Companies)*
- **Regulatory Agencies (EPA, DEC, Local)**

Therefore

I Foresee

Career Impacts of Climate Change

Increased Needs For Expertise

The Production Sector

- **Safe Production and Use of Non-Crop Based Renewable Energy (Including Nuclear!)**
- **Carbon Capture & Safe Long-Term Sequestration**
- **Water Quality Evaluation and Treatment**
- **Food Production and Distribution Technology**
- **Recycling Technology (Water, Process Streams, Discarded Products)**
- **Materials Selection and Fabrication**
- **Instrumentation and Automation**

Career Impacts of Climate Change

Increased Needs For Expertise

Project Realization

- **Process Design, Project Financing, Environmental Permitting**
- **Technology Transfer (Particularly to Developing Countries!)
–*Patent Issues, Technical Education for Users***

Career Impacts of Climate Change

Increased Needs For Expertise

Critical Widespread Needs

- **Longer-Range Planning**
 - *Governmental*
 - *Industrial*
- **Increased Consideration of 2nd Order Effects**
- **Vastly Increased Education of**
 - *The Public*
 - *Government Officials (including the Regulatory Sector)*

Career Impacts of Climate Change

Questions and (Perhaps) Answers