

INSTITUTION OF MECHANICAL ENGINEERS HONG KONG BRANCH
EVENING LECTURE “INNOVATIVE ENERGY EFFICIENCY STRATEGIES IN A
TRADITIONAL LOCAL BUSINESS” ON 23/6/2016



The lecture was held in Hong Kong Polytechnic University on 23/6/2016 [Wing-Hay Tsang]

Established in 1932, Pat Chun is one of the five (5) breweries of Chinese soy sources and vinegars in Hong Kong. While Pat Chun insists the tradition methods of producing Chinese soy source and vinegars, it embraces technologies and innovation to minimise the energy footprint of the production process, establishing itself a role model of energy efficiency in the food processing industry.

The two (2) primary products are Chinese soy sources and vinegars, which is the product of the fermentation of soy and rice respectively. However, the natural process of transforming soy bean and rice into the desired salty and sour aroma on the dinning table is chemically complex and lengthy.

Brewing Tradition

The right climates are utilised for brewing soy sources. The heat and humidity in spring and summer in Hong Kong, being both high, are leveraged to facilitate the mixture of soy bean, water, salt and the filamentous fungus, *aspergillus oryzae*, also known as koji, to ferment, whereby the protein in the soy bean is broken into peptides. By when autumn comes, the peptide liquid is transferred and stored into the open mouth clay jars on the building roof, where the peptides are then broken by enzymes, yeasts, lactic acid and bacteria under the exposure of sun and low relative humidity to become amino acid. It is at this time, the amino

acid delivers the mellow flavour, and the resulted fluid is ready to be bottled and become soy source. The entire process, spanning across early spring to late autumn takes nine (9) months.

The brewing of vinegar is a three (3) step biological-chemical process. Inside the giant clay jars, the major ingredient of rice is mixed with water and is turned into sugar by koji. With the facilitation of yeast, the sugar is transformed to become rice wine liquid and lees. The acetobacter converts the rice wine liquid into rice vinegar, the final product, and lees into rice pulp. In spite of the conversion of wine to vinegar produces heat, a cool environment favours the conversion to take place.

The brewing of both soy source and vinegar involves fermentation, which itself is in either liquid or solid state. In the former state of fermentation, inside the vessel, the grain at the bottom is fermented by the bacteria present in the water at the middle layer, leaving air at the top layer. Taking longer time to process, the resulted fluid is yellowish and smooth in texture, making it suitable for cooking. The latter state, however, the bacteria attaches to the surface of the grain. The fermentation takes place with the absence of water and shorter time to carry out, yielding the resulted fluid carries stronger grain flavour which is good for dipping.

Produce Efficiency

Pat Chun has estimated the baseline of total energy consumption is 100,000 kWh per month. Although the process of producing soy source and rice vinegar itself consumes no energy directly, the steps of further processing rice vinegar to become various vinegar products such as pork knuckles and ginger stew, which requires extensive heat input, is energy consuming. In addition, the fermentation and brewing processes require different climate conditions and hence different energy inputs. Minimising the production carbon footprints and hence costs, various energy-efficient installations are incorporated into the Pat Chun purpose built production building in Tseung Kwan O Industrial Park, one of the three (3) dedicated compounds for facilitating industry and advanced technology developments owned by the statutory Hong Kong Science and Technology Park Corporation.

While cooking is identified the greatest single energy consumer in the Pat Chun production business, all lines of the cooking process adopt highly energy efficient induction cookers. Moreover, each induction cooker cooks over one (1) ton of sources, utilising the latent heat in the cooked fluids.

Coupling the cooking process, the heat in the evaporated steam generated is recovered to heat water and feed the hot water supply. Since the evaporated steam is acidic, the heat exchanger is made of the corrosion-resistant titanium alloy. About 2,000 kWh of energy is recovered per month, which is equivalent to 2 % of the total energy consumption baseline and HK\$2,000 power bill reduction. However, since not all hot water generated is consumed within the production process, the payback period is estimated to be about eight (8) years.

The freshly cooked products are high in temperature and are subject to cooling in order to proceed with packaging. In the past, air-conditioning units were used for the heat removal. Nevertheless, the cooling was often unreliable because the cooked products and hence the atmosphere were hot and acidic, causing the units to break-down. While the ordinary fans were insufficient to cool the process, the three (3) high volume low speed (HVLS) fans, each in 12" / 3,657.60 mm diameter installed with 7 to 8 m floor height, however, are able to draft large amount of cool air for cooling highly effectively. Comparing to the baseline of using

air-conditioning, each HVLS fan can save 3,000 kWh per month, equivalent to 3 % of the total monthly power consumption and HK\$3,000 power bill reduced every month. The costs of the HVLS fans were recovered in six (6) months.

As explained, the fermentation for producing soy source takes place in both the temperature and humidity being high and is limited to the spring and summer months for the process to carry out naturally. Pat Chun overcomes the seasonal constraints by coupling the high temperature demand with the constant cooling requirement from the server room and vinegar brewing. This is attained by the use of heat pumps manipulate the heat allocation and effectively control the climate of two different environments. The heat pump transfers the heat generated by the computer servers and vinegar brewing to the koji room of soy source production, enabling the soy source fermentation to carry out in months when the ambient temperature is low. In doing so, the soy source production is no longer be season-sensitive whereas a year-round business, improving both productivity and energy efficiency.

A standard reference model in the context of seasoning production in Hong Kong has not been available to Pat Chun for baseline comparison. As a result, Pat Chun has relied upon an imaginary baseline of no energy efficient measure is implemented at all in quantifying the results of the energy saving initiatives. With the adoption of the aforesaid induction cookers, heat recovery, HVLS fans and heat pumps as well as extensive use of T5 fluorescent lighting, which consumes less electricity than LED lighting, across the building, 15 % reduction from the baseline has been achieved. It is targeted that, with the continuous improvements on efficiency, a 30 % reduction will be met, yielding an overall payback of the energy efficient initiatives to be four (4) to five (5) years.

Pat Chun is a long-participant of the famous long-history Hong Kong Brand and Products Expo (BPE), an open to public outdoor trade fair for promoting local industries and productions organised by The Chinese Manufacturers' Association of Hong Kong which is held in Victoria Park now annually. The mega-sized neon light plaque and flower plaque displayed above the Pat Chun booth have become an icon of both Pat Chun and BPE. Pat Chun has identified that materials and the construction of the booth have contributed almost 80 % of the normalised carbon footprint for a standard booth and, by reusing the neon light plaque and using the flower plaque made of recyclable materials such as bamboo, Pat Chun has achieved 50 % reduction in life-cycle environmental impact in its BPE booth. Such effort has resulted in Pat Chun conferred the Most Environmentally Friendly Stall Awarded of BPE.

Engineering Tradition

Pat Chun is a family business and has come to the third generation of management. Blessedly both the second and third generations were endowed with sound mechanical engineering knowledge and experiences and project management expertise before joining Pat Chun. The second generation once served in the local power company while the third generation in a global engineering consultancy specialised in energy efficient buildings in Hong Kong and overseas, and both of them are Corporate Members of Institution of Mechanical Engineers (IMechE). All the energy efficient initiatives in the purpose-built Pat Chun production building were decided by the Pat Chun management and the tender documents for the full cycle of the project were compiled in-house. The project was hands-on managed by the Pat Chun itself until the completion of the project in 2012.

The story of Pat Chun is a clear demonstration that all businesses, even the small local ones, can bear the fruit of high productivity and lower production cost with the embracement of energy efficient initiatives. Even though as ordinary and traditional as soy source and rice vinegar, mechanical engineering can also find its position to contribute yielding the original and natural taste.



The speaker, Dr. Trevor Ng (second left), received the certificate of appreciation after the lecture [Wing-Hay Tsang]

IMechE Hong Kong Branch thanks Dr. Trevor Ng, Managing Director of Pat Chun for his insightful and inspiring sharing.

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Encl.
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八珍甜醋份外香



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Patchun in Hong Kong



Flagship Mongkok Store

Patchun Building and Brewery

工展會

Brewery

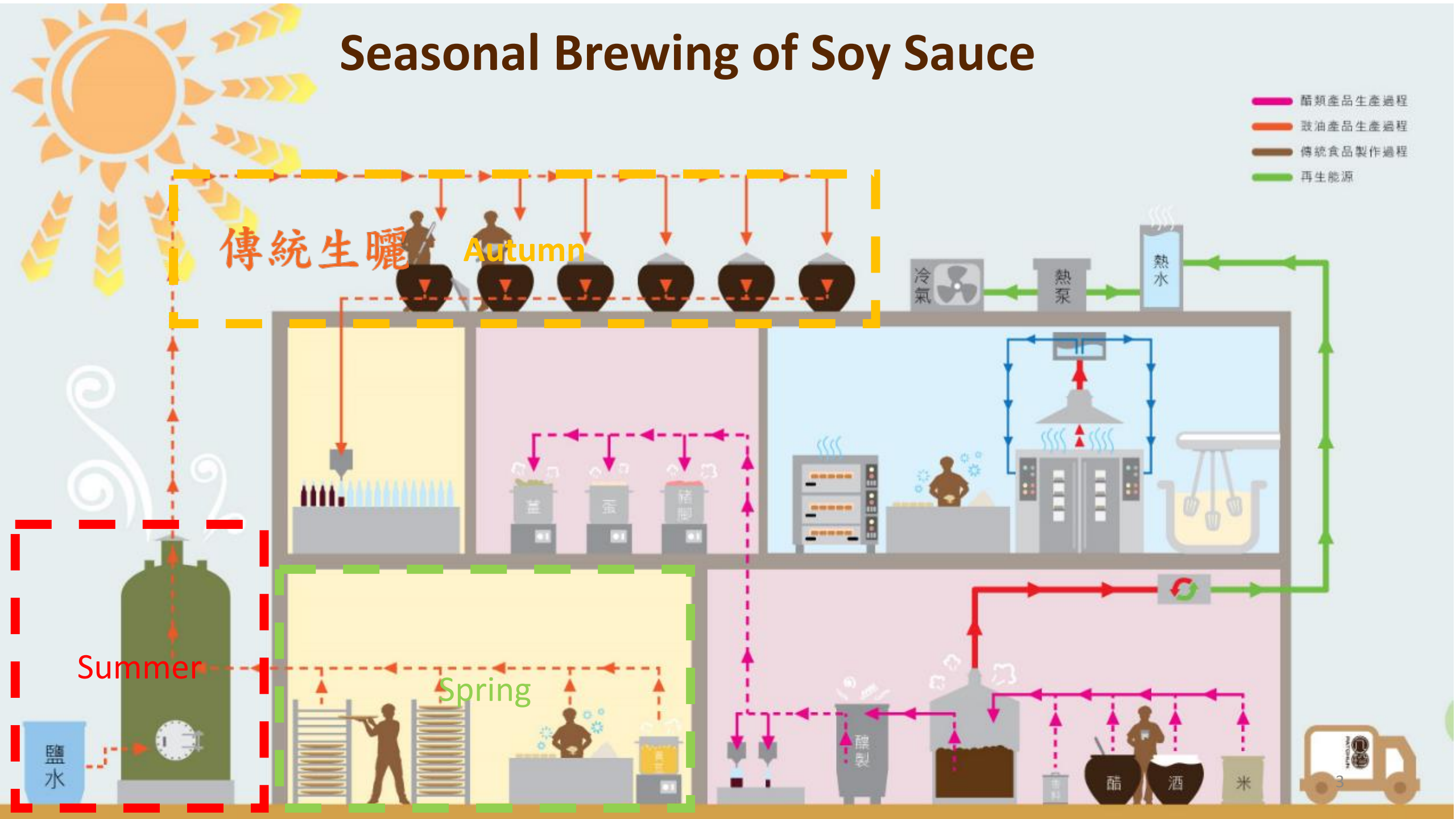
Flagship Store

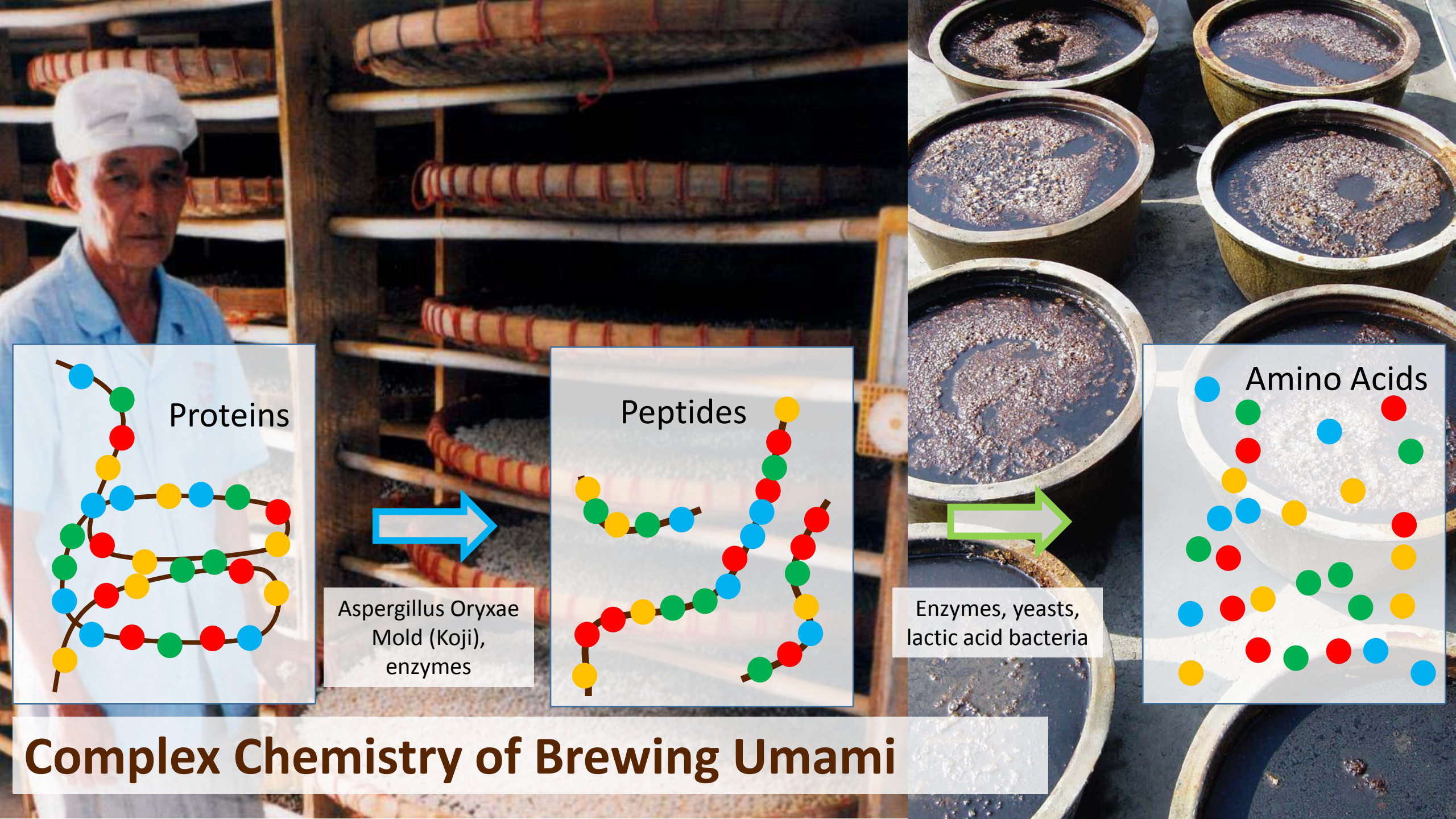
Retail shops

Temporary Exhibitions

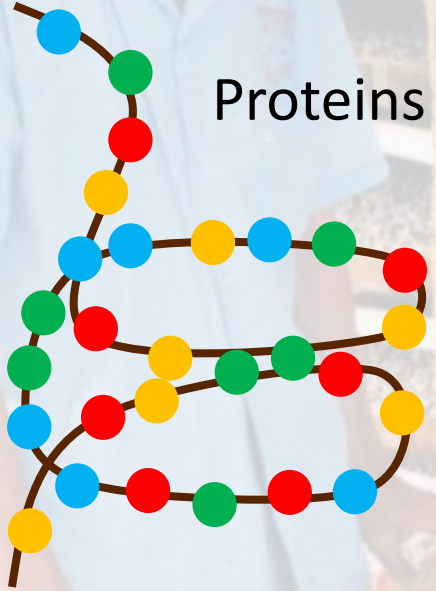
Seasonal Brewing of Soy Sauce

- 醃類產品生產過程
- 製油產品生產過程
- 傳統食品製作過程
- 再生能源





Proteins



Aspergillus Oryzae
Mold (Koji),
enzymes



Peptides



Enzymes, yeasts,
lactic acid bacteria



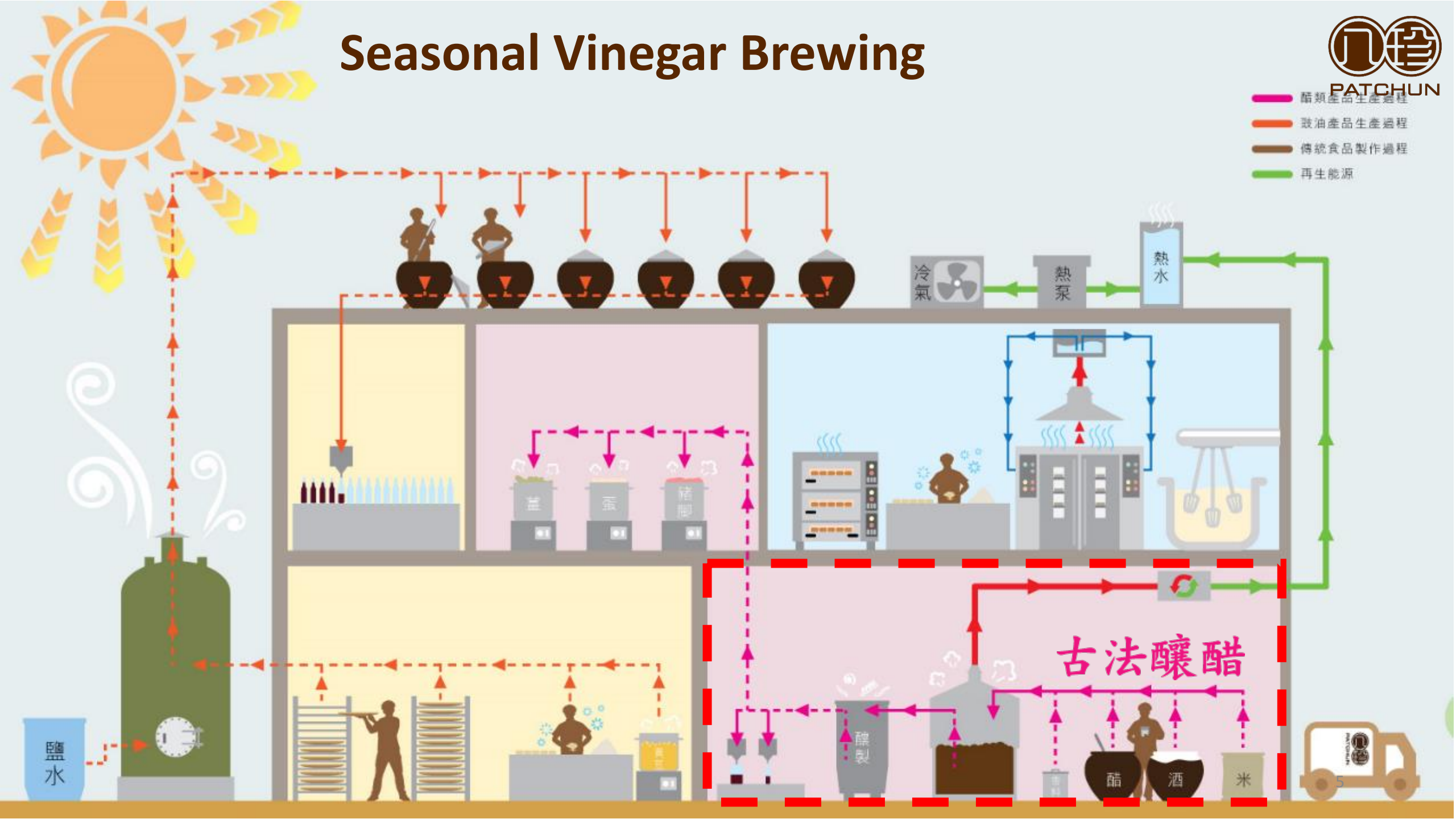
Amino Acids



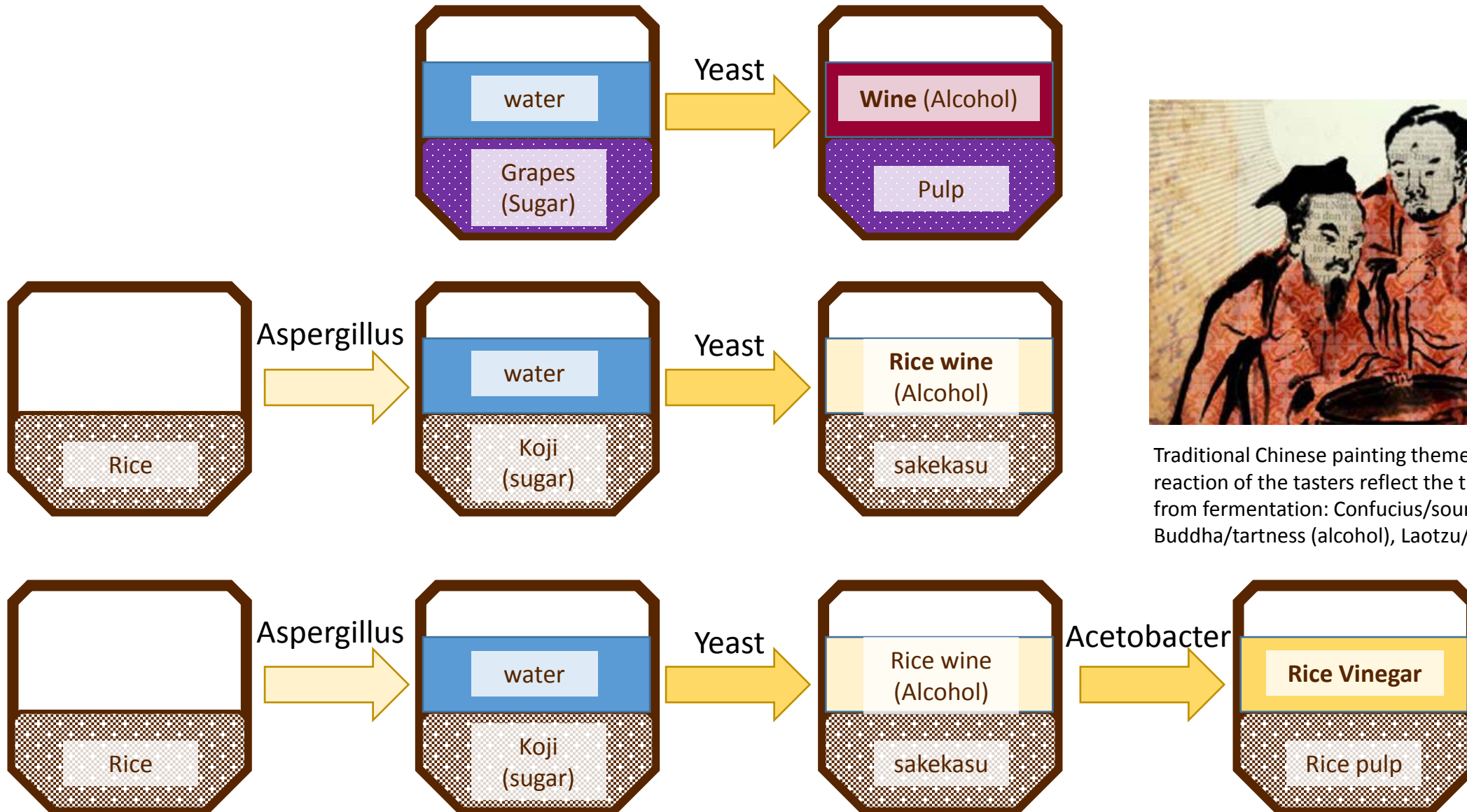
Complex Chemistry of Brewing Umami

Seasonal Vinegar Brewing

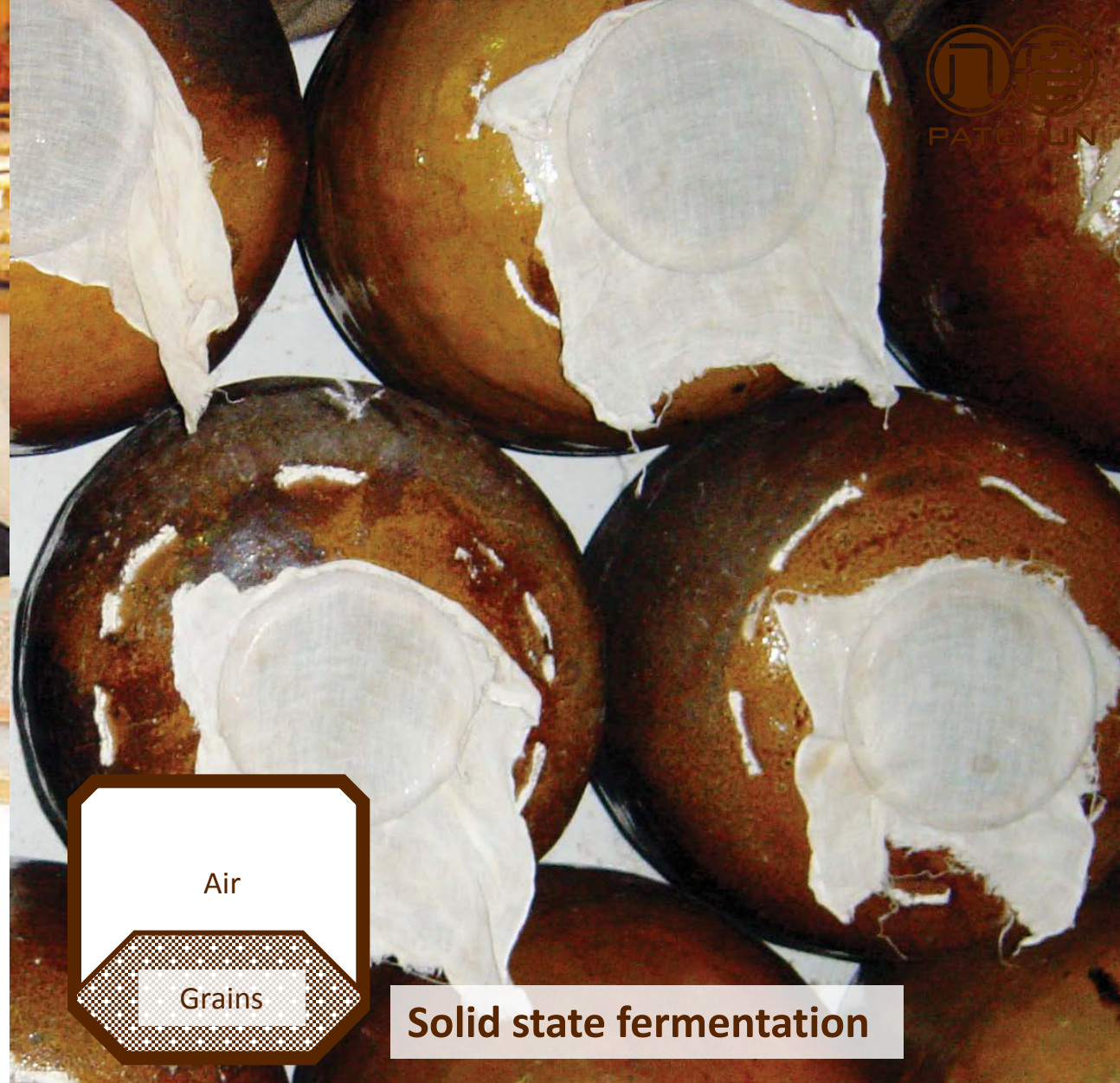
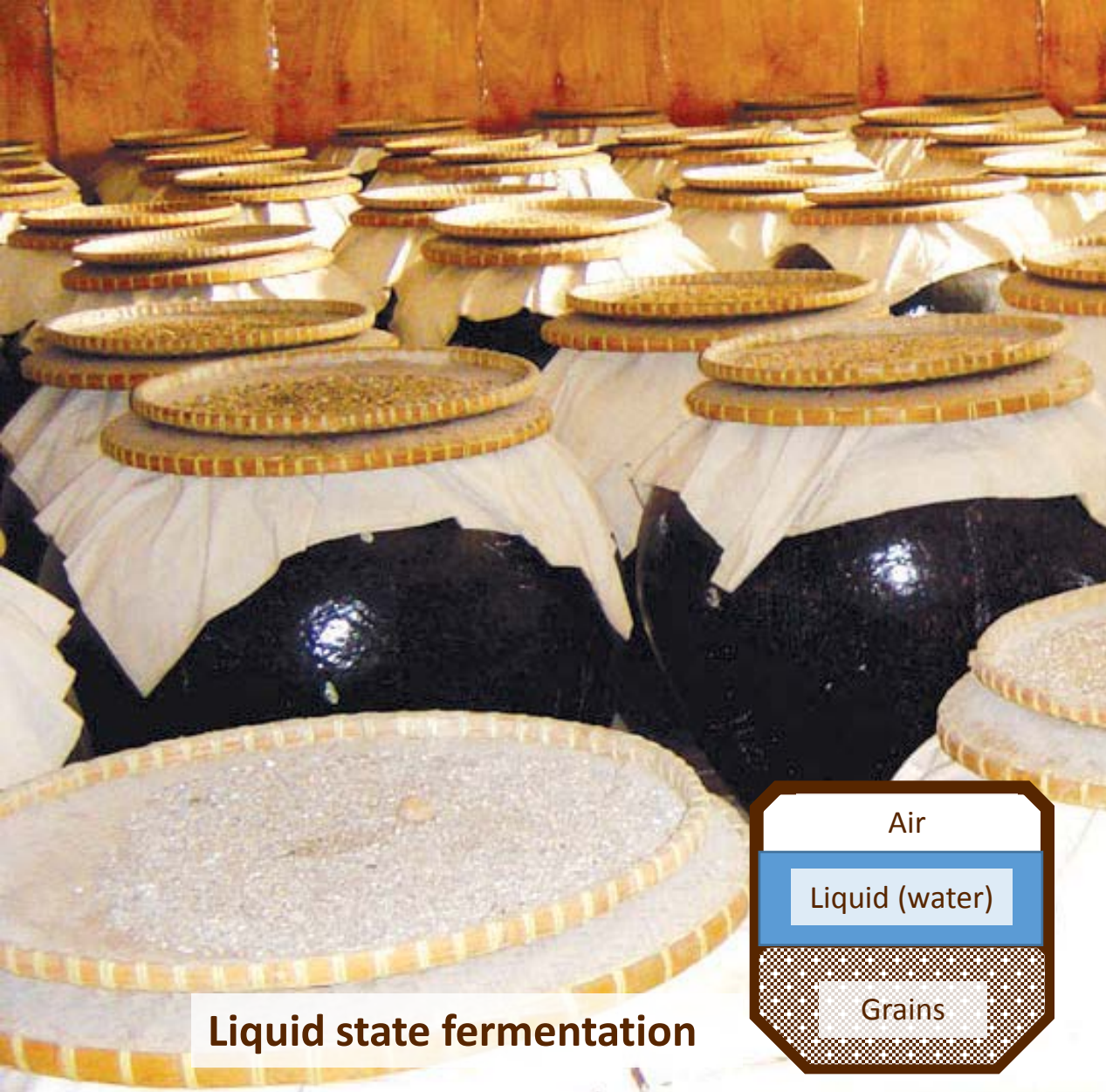
- 醋類產品生產過程
- 鼓油產品生產過程
- 傳統食品製作過程
- 再生能源



The Three Stages in Chinese Vinegar Brewing



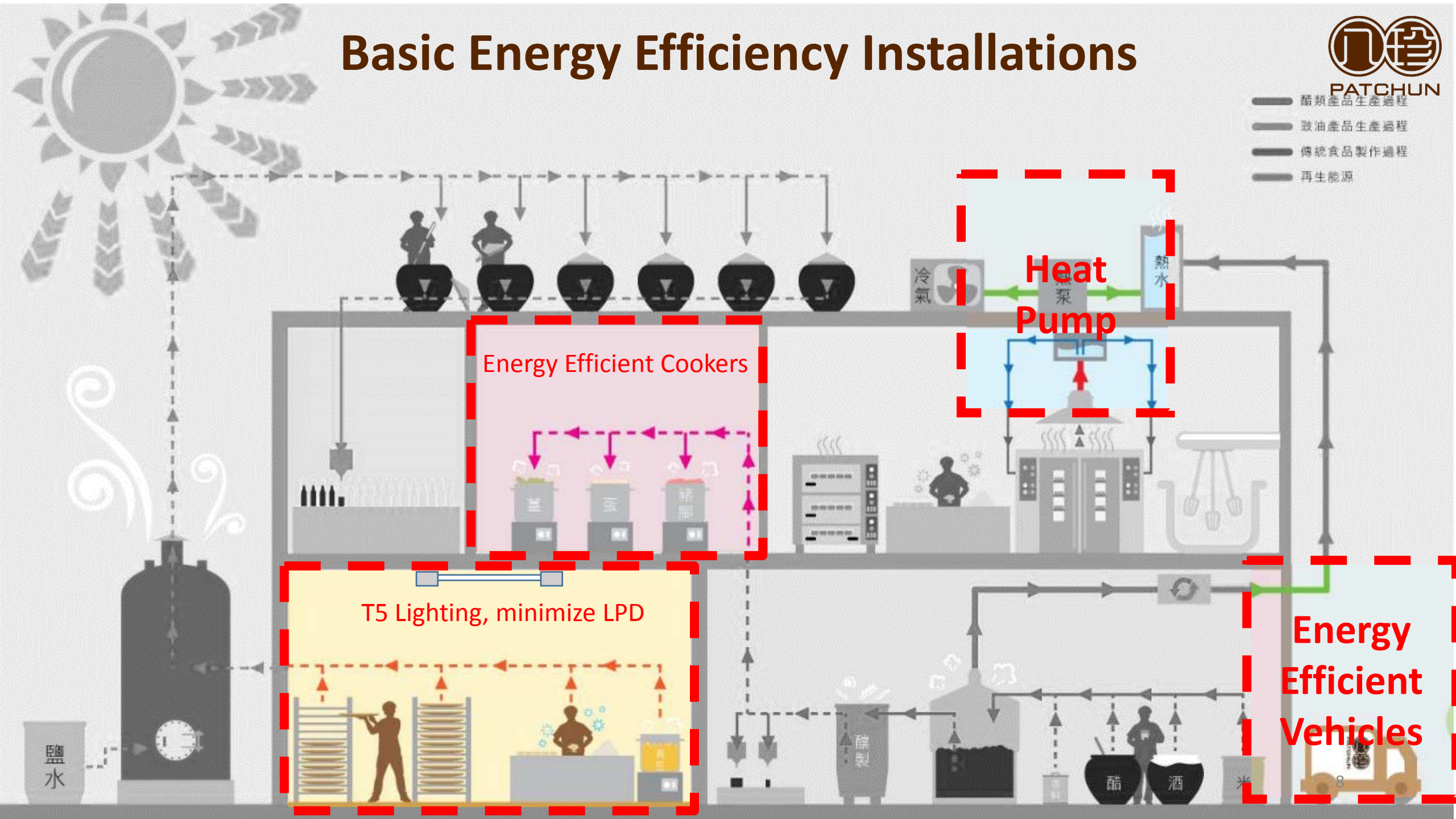
Traditional Chinese painting theme: the vinegar tasters. The reaction of the tasters reflect the three main flavors resulting from fermentation: Confucius/sourness (acetic acid), Buddha/tartness (alcohol), Laozi/sweetness (sugars)



Vinegar Brewing Technique and Flavors

Basic Energy Efficiency Installations

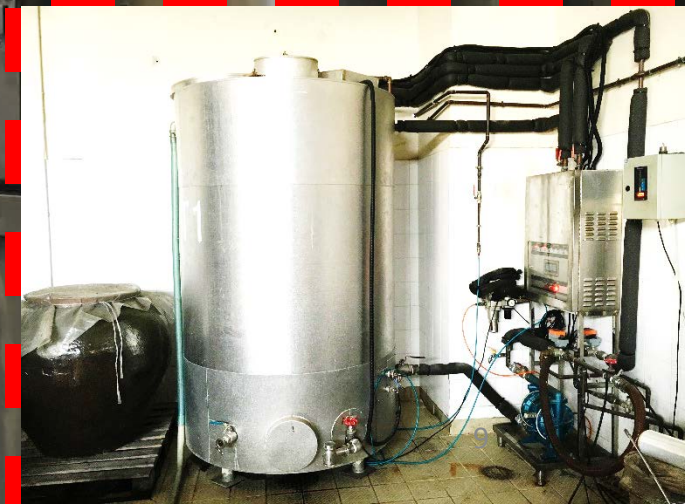
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- 豉油產品生產過程
- 傳統食品製作過程
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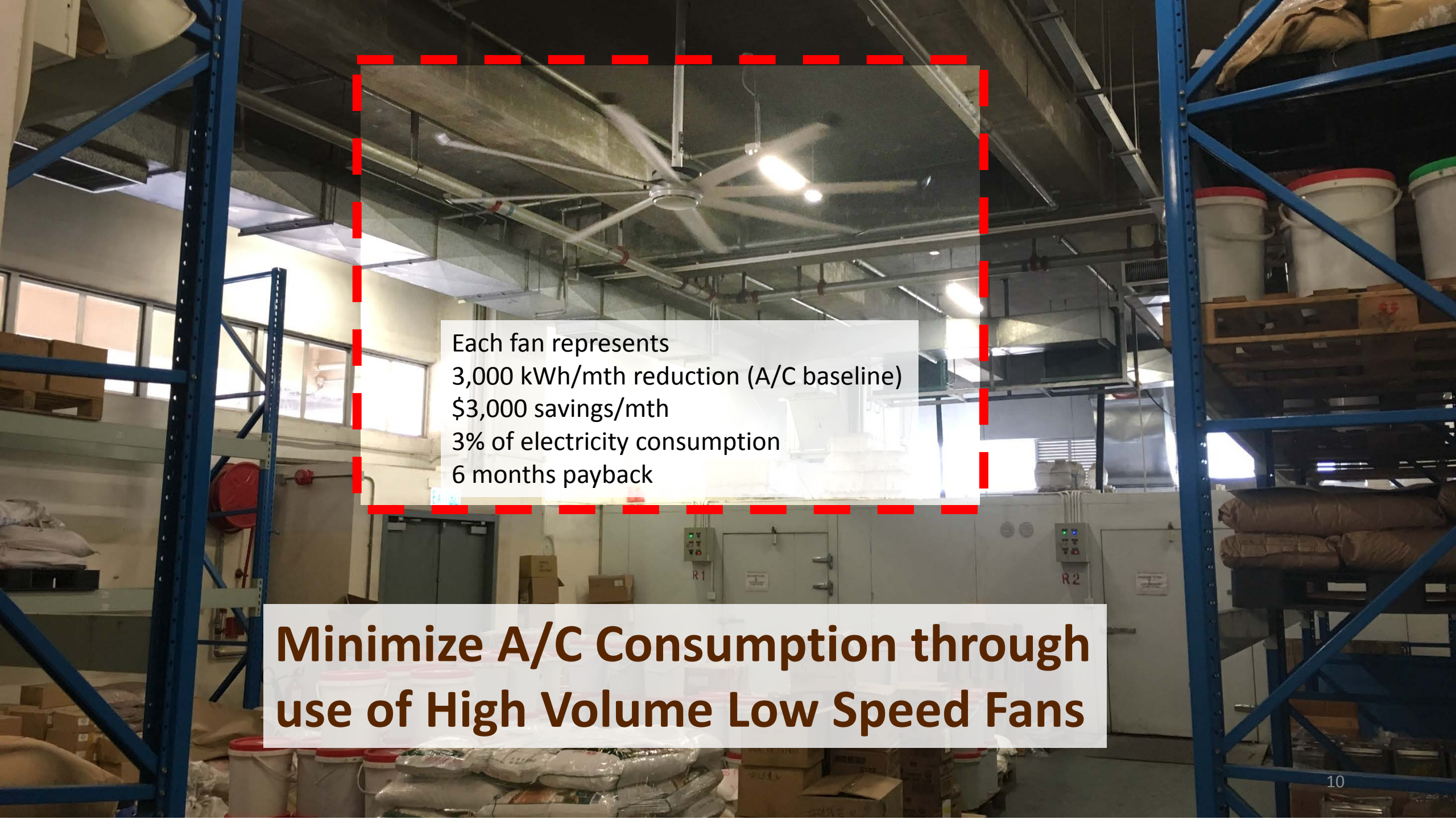




Heat Recovery and Hot water
System
2000kWh/ mth
\$2000 savings/mth
2% of energy consumption
8 years payback

**Minimize Cooking Energy Consumption
through Heat Recovery Systems**



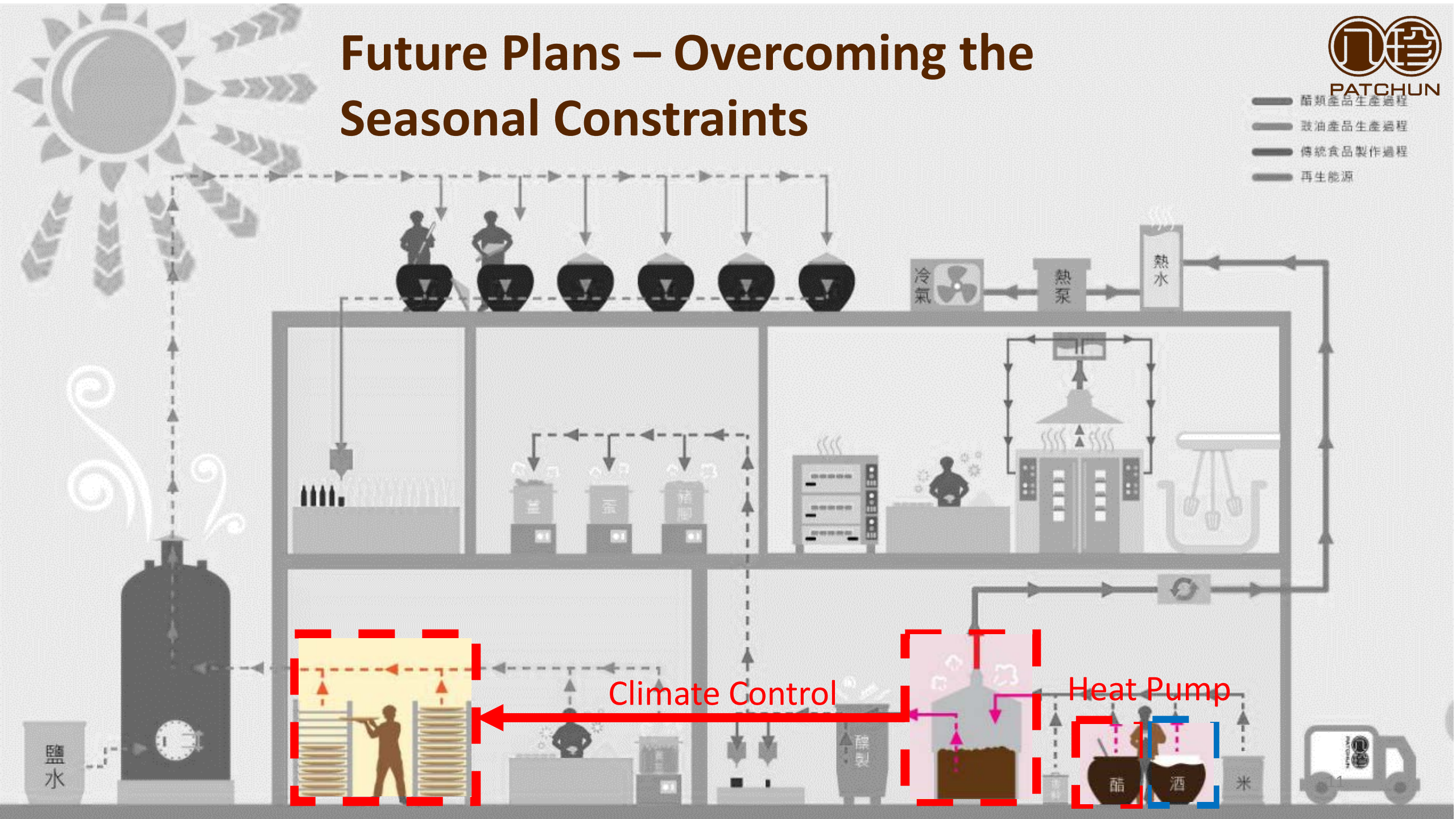


Each fan represents
3,000 kWh/mth reduction (A/C baseline)
\$3,000 savings/mth
3% of electricity consumption
6 months payback

**Minimize A/C Consumption through
use of High Volume Low Speed Fans**

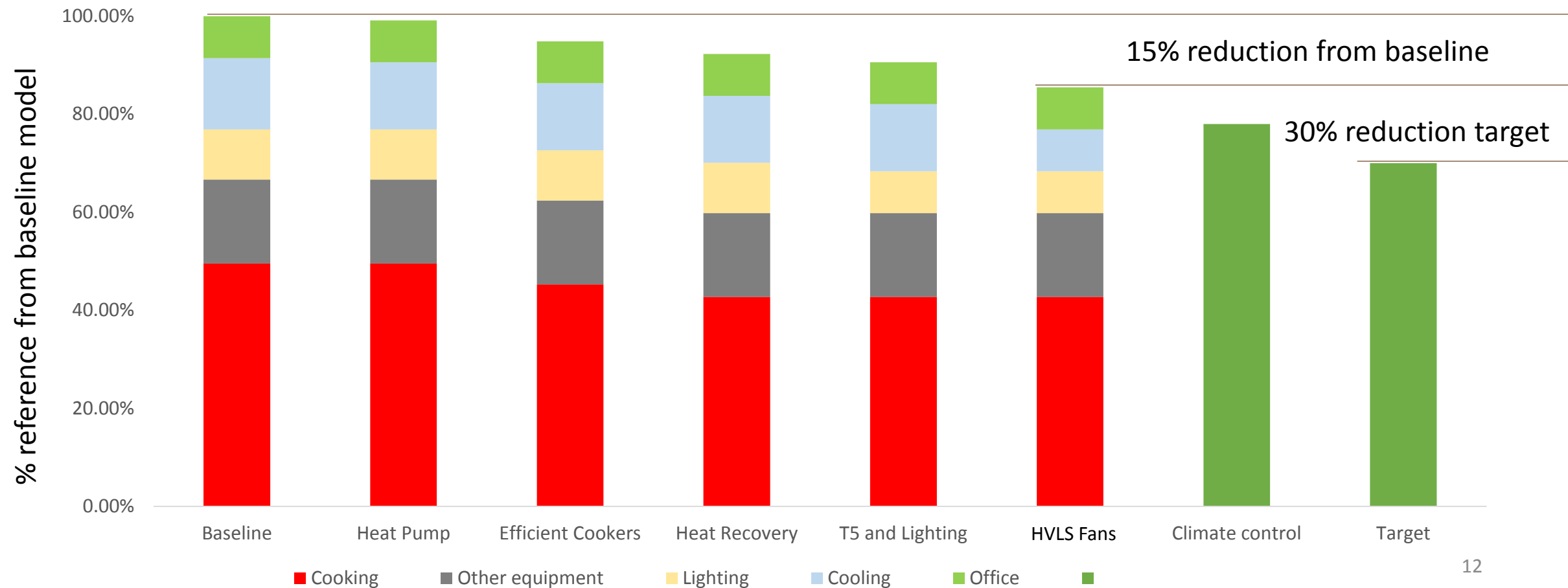
Future Plans – Overcoming the Seasonal Constraints

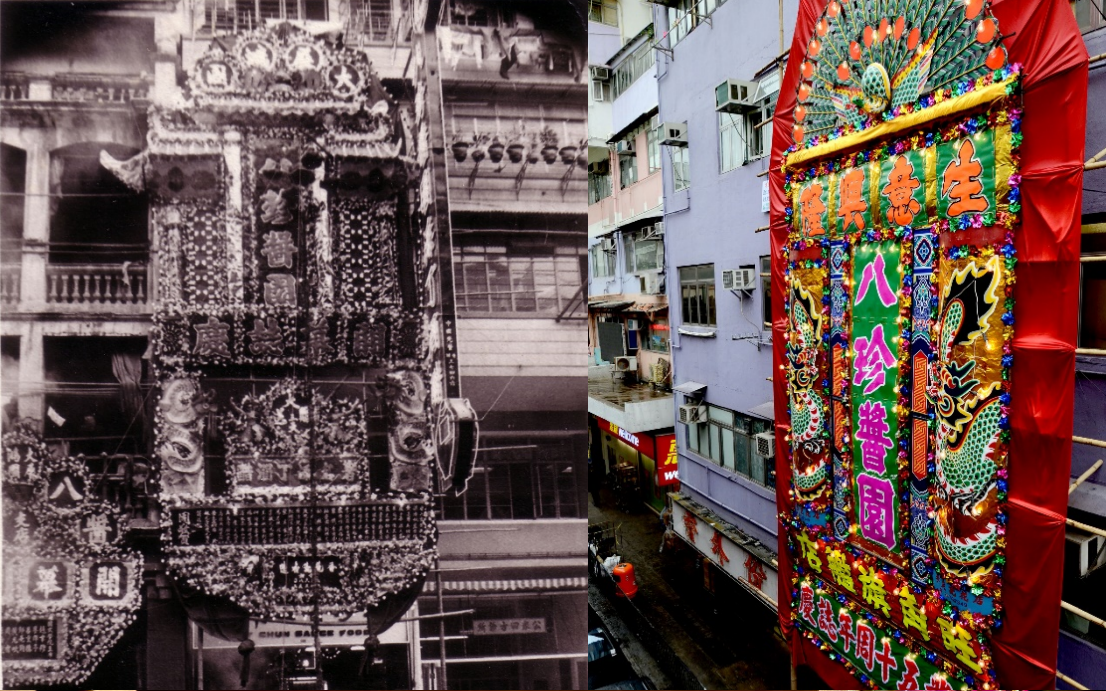
- 醋類產品生產過程
- 豉油產品生產過程
- 傳統食品製作過程
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Energy Reduction

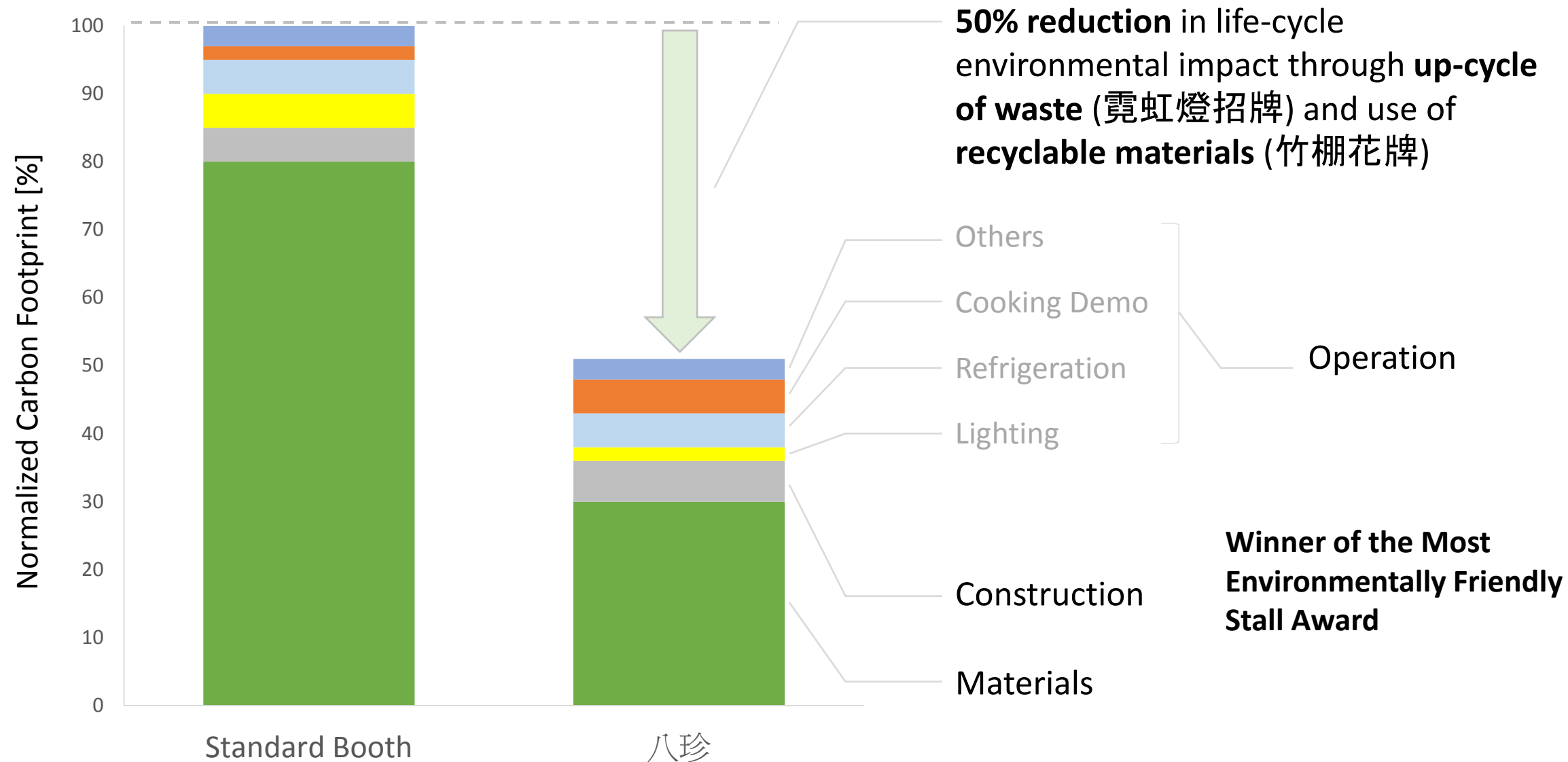
- Energy consumption dominated by process loads, there are no standard reference model for baseline comparison. Also limited by metering constraints
- Comparison based on an imaginary baseline where we did not adopt any energy efficiency considerations
- **Current initiatives result in 15% reduction (\$200,000 savings/year), Target 30% (Overall payback 4 to 5 years)**





Recycled and Re-Usable Construction and Fit-Out

Life Cycle Environmental Impact of a BPE Stall



八珍甜醋份外香



- A flavor of how local traditional sauces are fermented and brewed
- A sampling of energy efficiency and environmental initiatives that are relevant to small local businesses
- A taste of what life can be like after engineering



Do like 八珍醬園 on Facebook (slides will be available on our page) or contact trevor.ng@patchun.com if you will like to learn more



IMechE Hong Kong Branch
Activity Sub-Committee
Education and Training Group

TECHNICAL SEMINAR Innovative Energy Efficiency Strategies in a Traditional Local Business

Hong Kong Branch

Institution of
**MECHANICAL
ENGINEERS**

Date: 23 June 2016
Time: 19:00 to 20:30
Venue: FJ301, PolyU
Speaker: Dr. Trevor Ng,
Patchun Managing Director

IMechE Hong Kong Branch brings you an experience sharing session on how modern energy-efficiency improvements have successfully enhanced a traditional sauce brewer in Hong Kong.

About the Speaker:

Dr. Trevor Ng is the managing director of Patchun – a traditional family-run brewer of Chinese sauces with 84 years of history. Before taking over the family business, Trevor was a Senior Engineer at Arup, specialising in the design of energy efficient buildings and felt very fortunate to have participated in a number of memorable projects, including the master plan of the West Kowloon Cultural District, CIC Zero Carbon Building, and the environmental canopy at Southbeach in Singapore. Trevor found his training as an engineer very useful in running a business, and has also introduced number green measures into the production of sauces.

Free admission

For detail, please visit IMechE webpage:

<http://nearyou.imeche.org/near-you/north-east-asia/hong-kong/events>