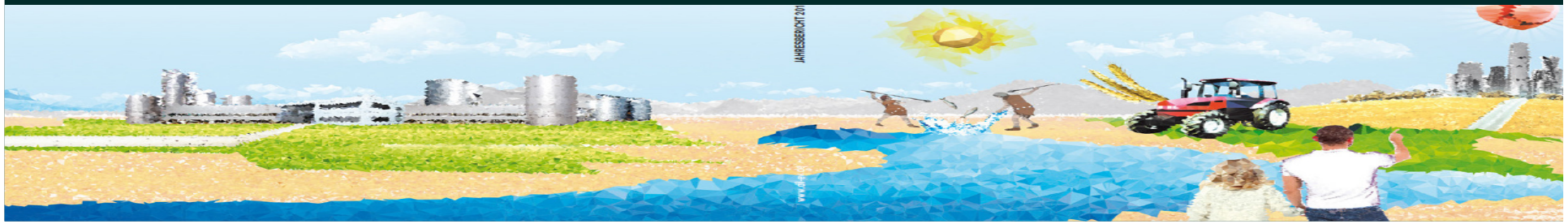
Innovation in Food Technologies

Volker Heinz

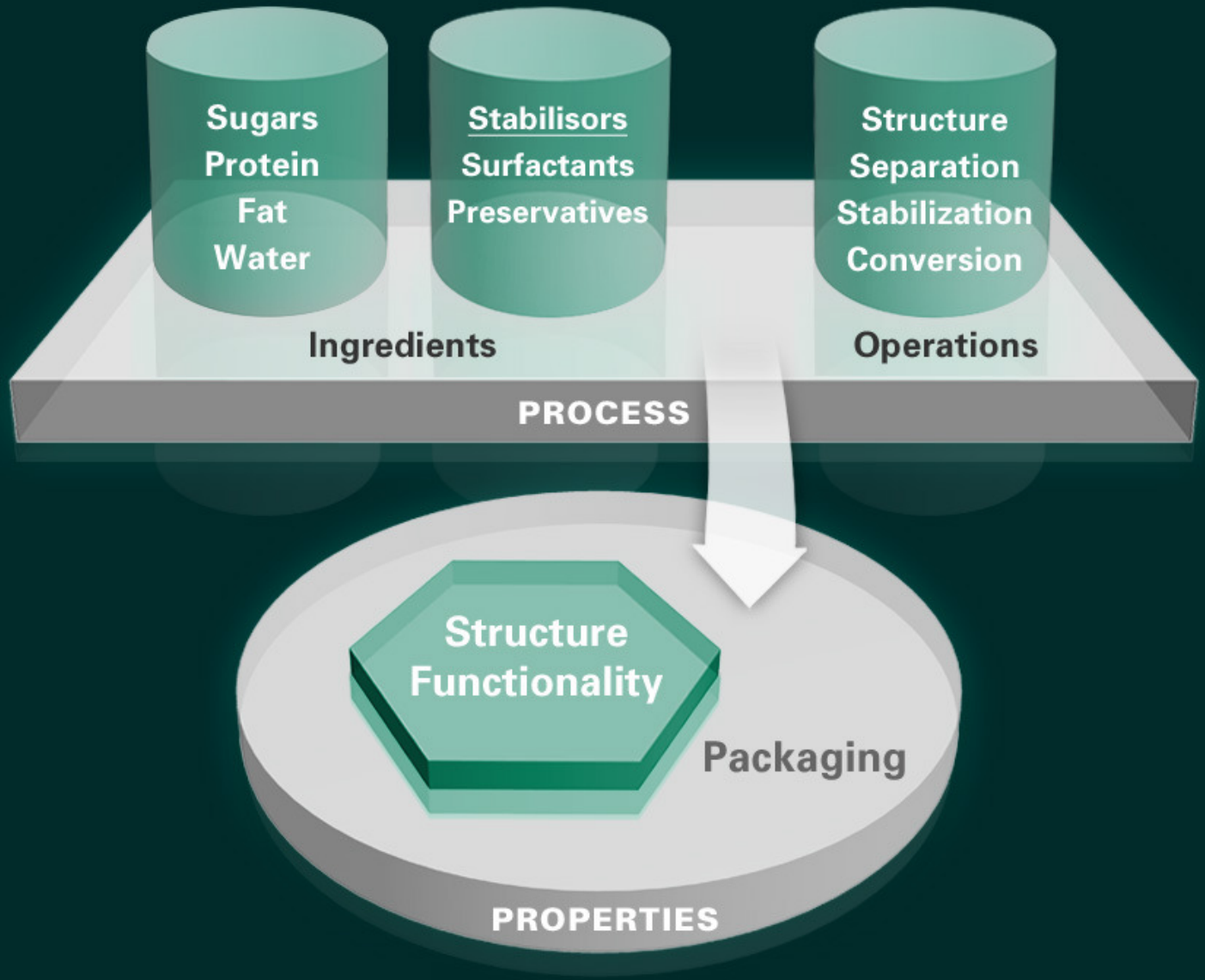
(June 2014)

Innovation in Food Technologies

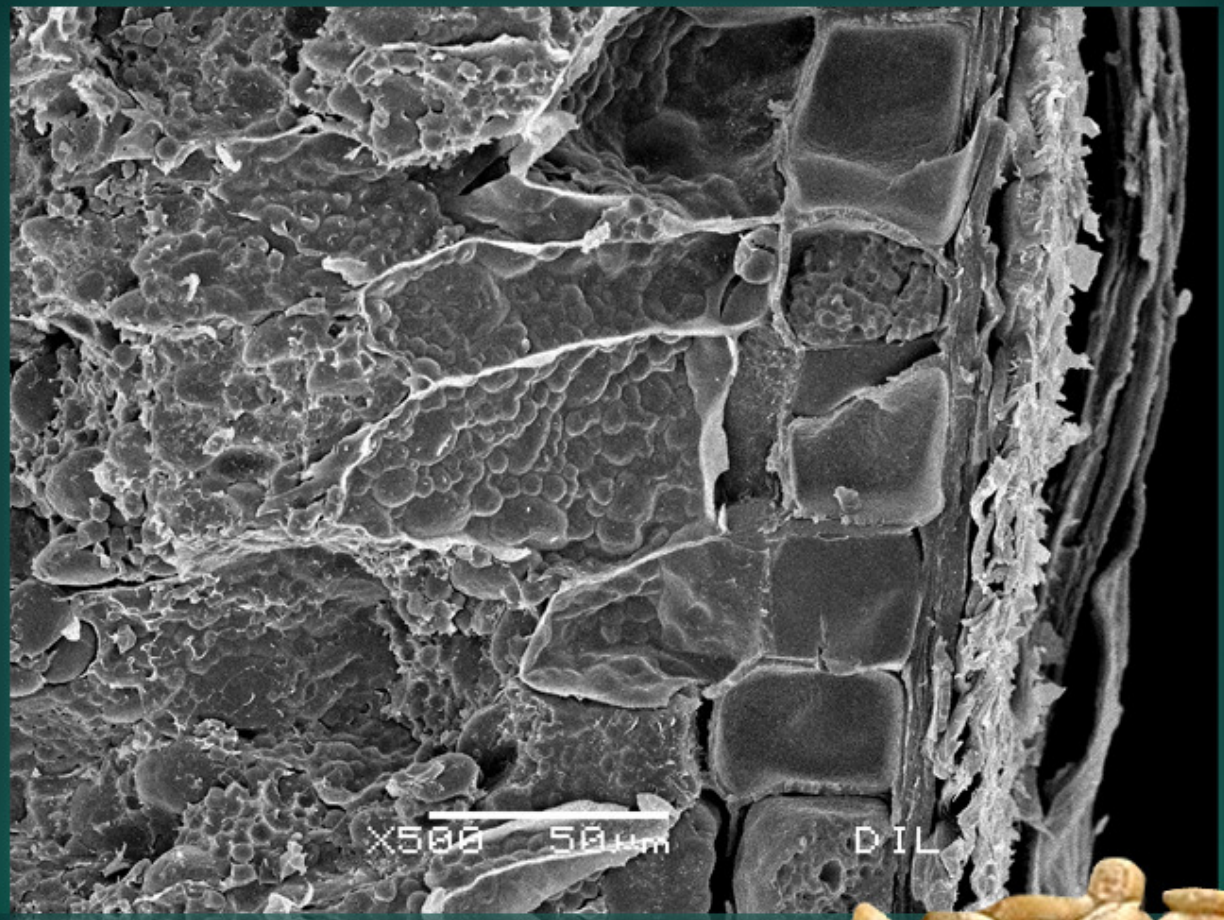
- Food Processing
- Advanced Technologies: Shockwave – PEF - Packaging
- Drivers for Innovation:
  - Health & Wellbeing
  - Demographics
  - Health & Hunger
  - Urbanization
  - Small(er) Scale Processing
  - Like Meat ?
- Conclusion



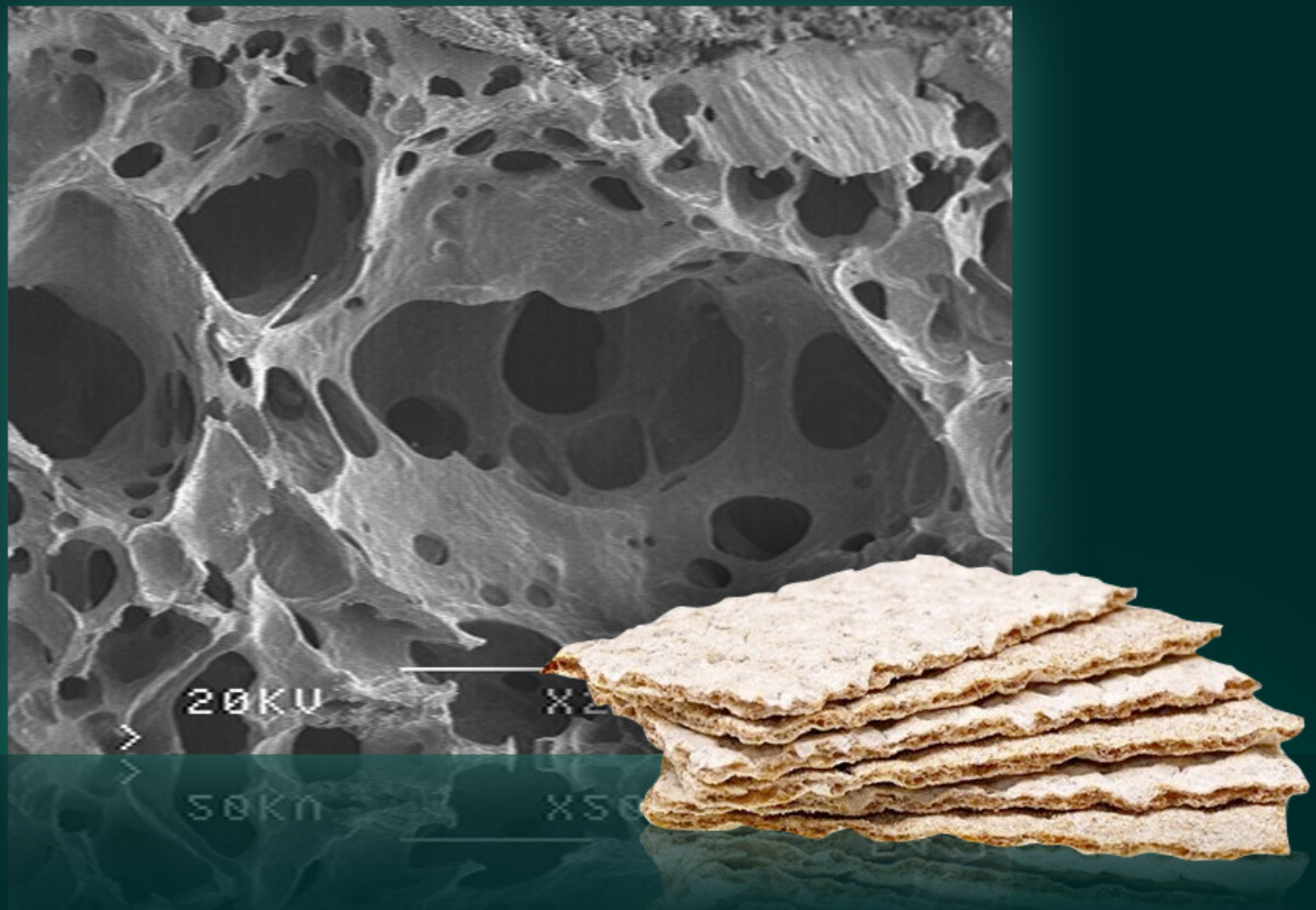
Food processing



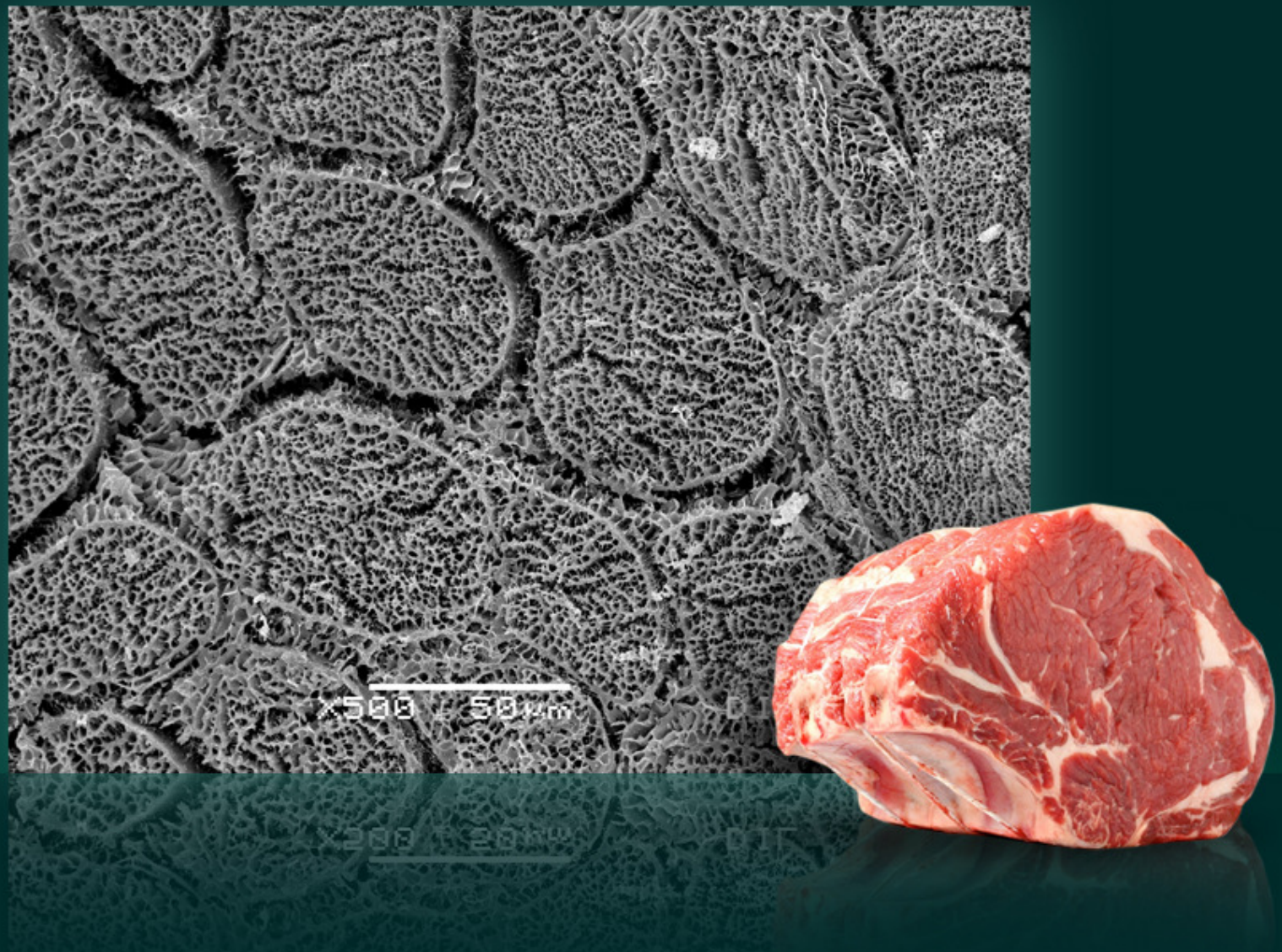
GRAIN



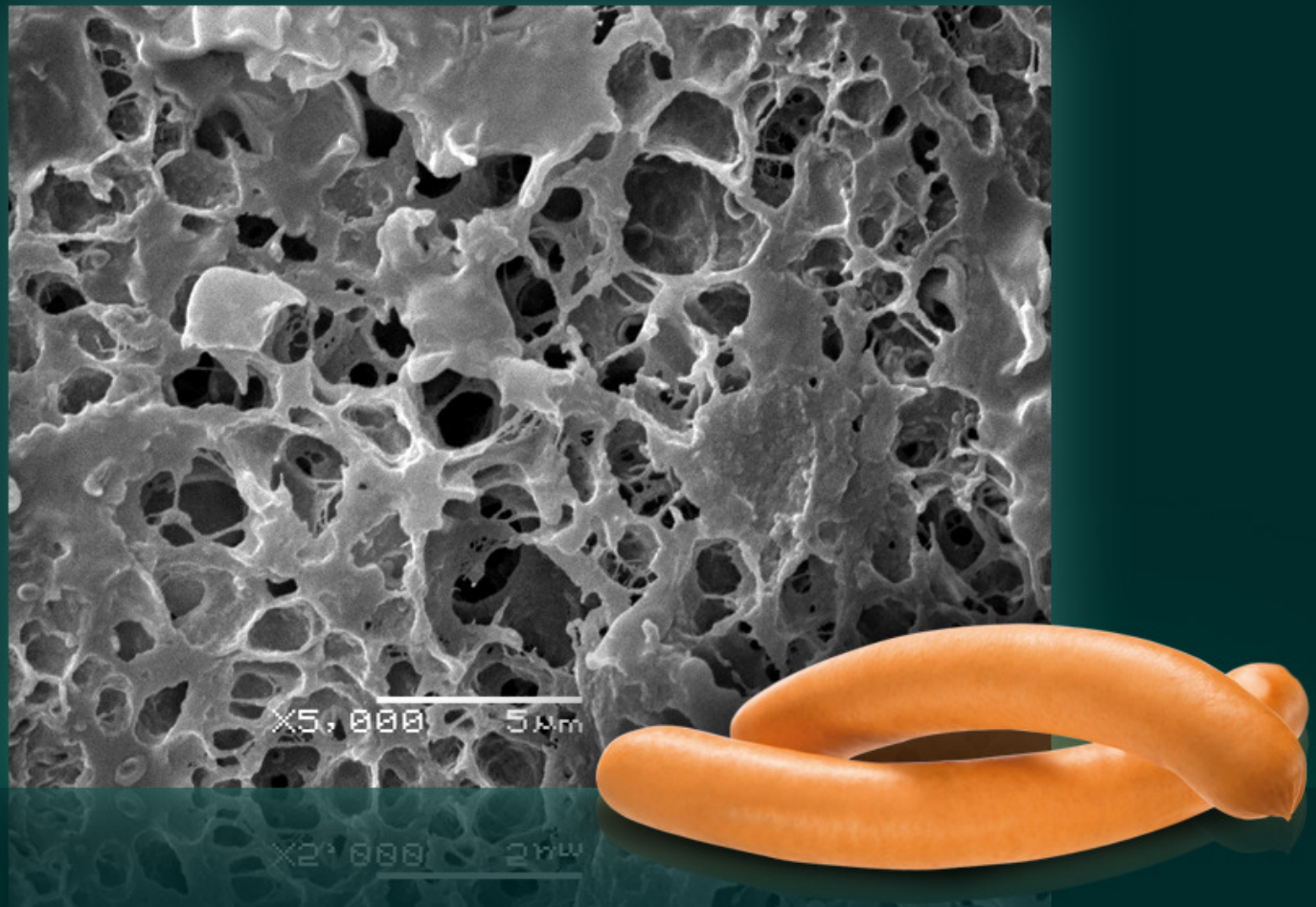
BREAD



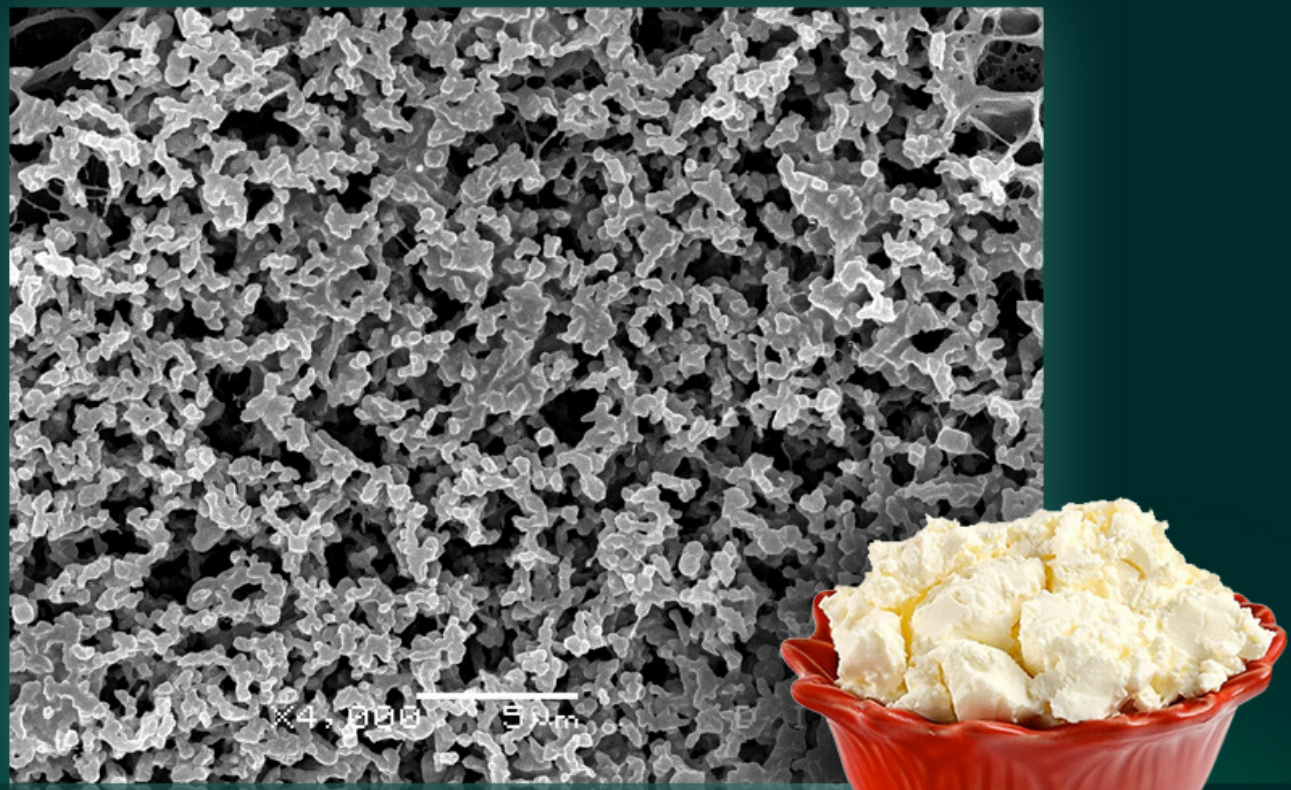
MEAT



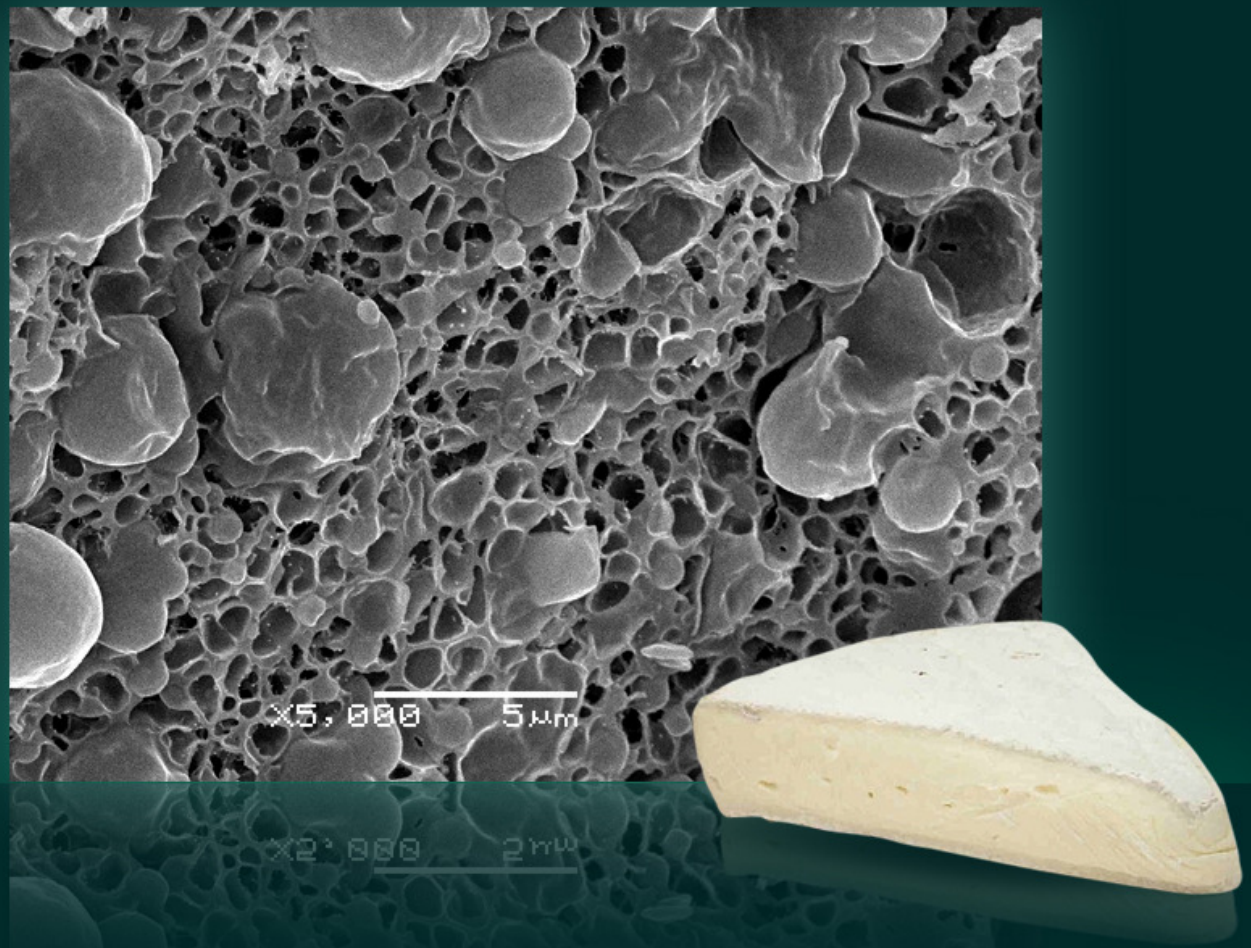
SAUSAGE



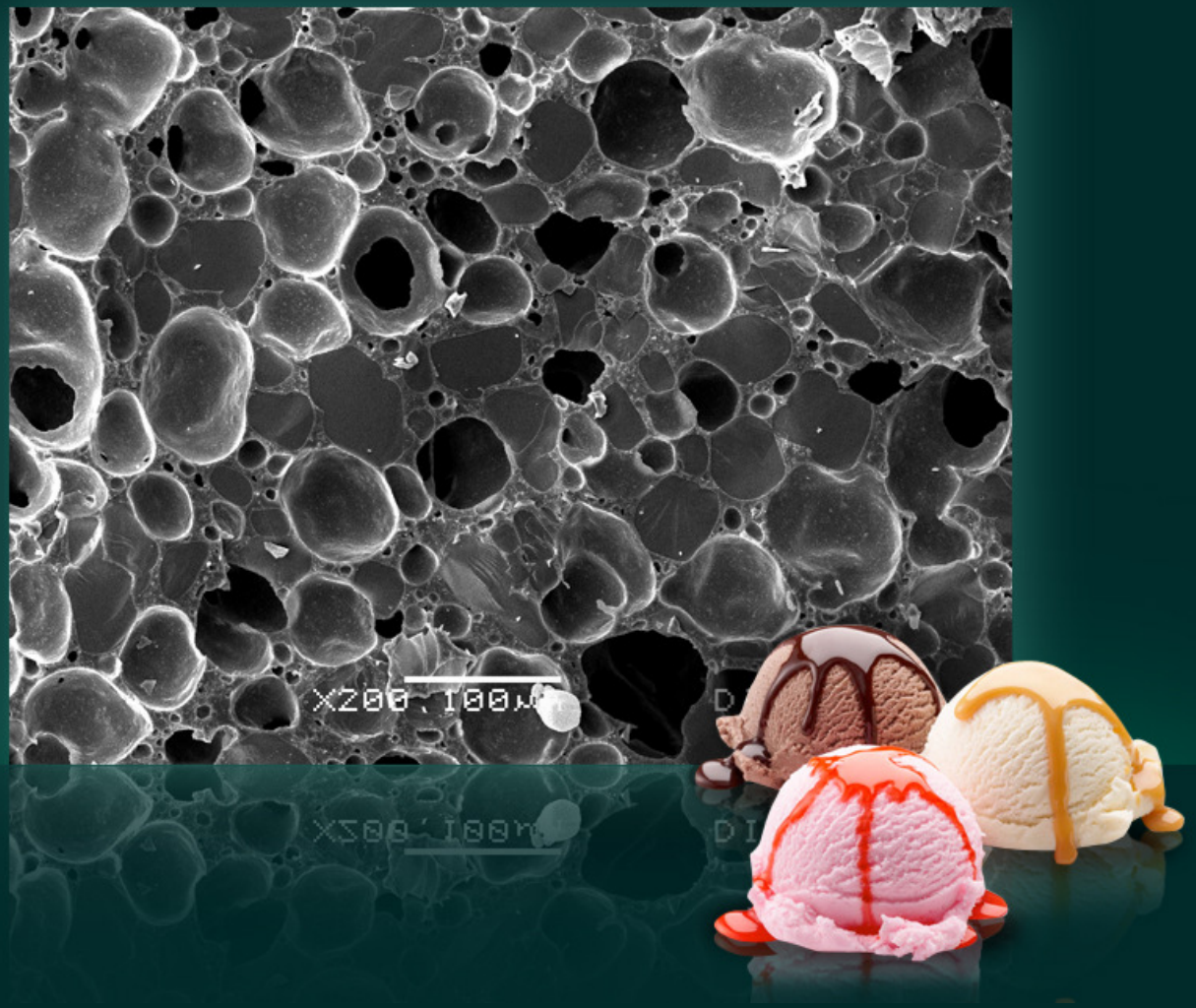
FRESH CHEESE



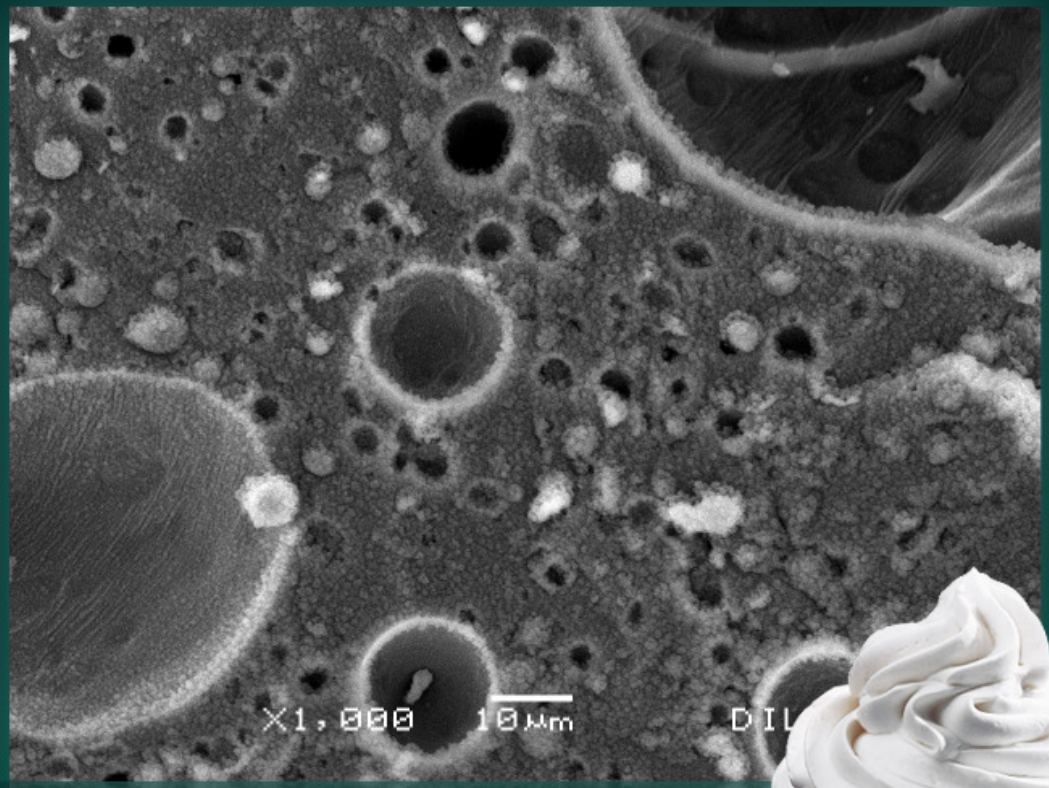
CHEESE



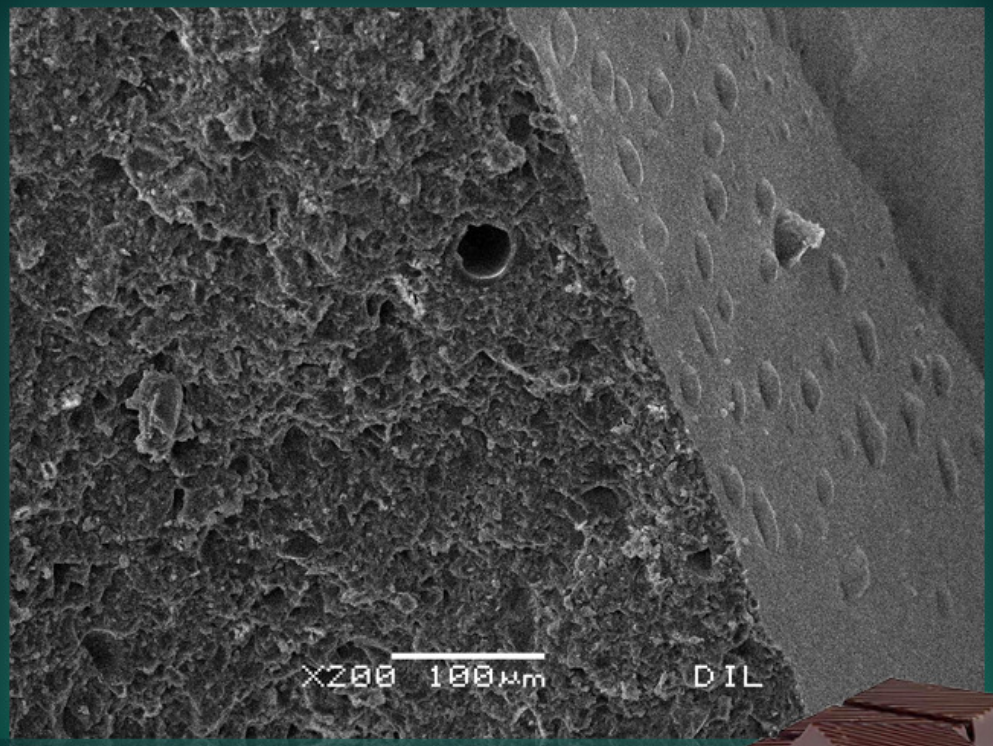
ICE CREAM

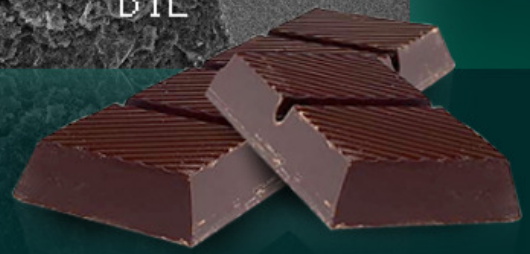


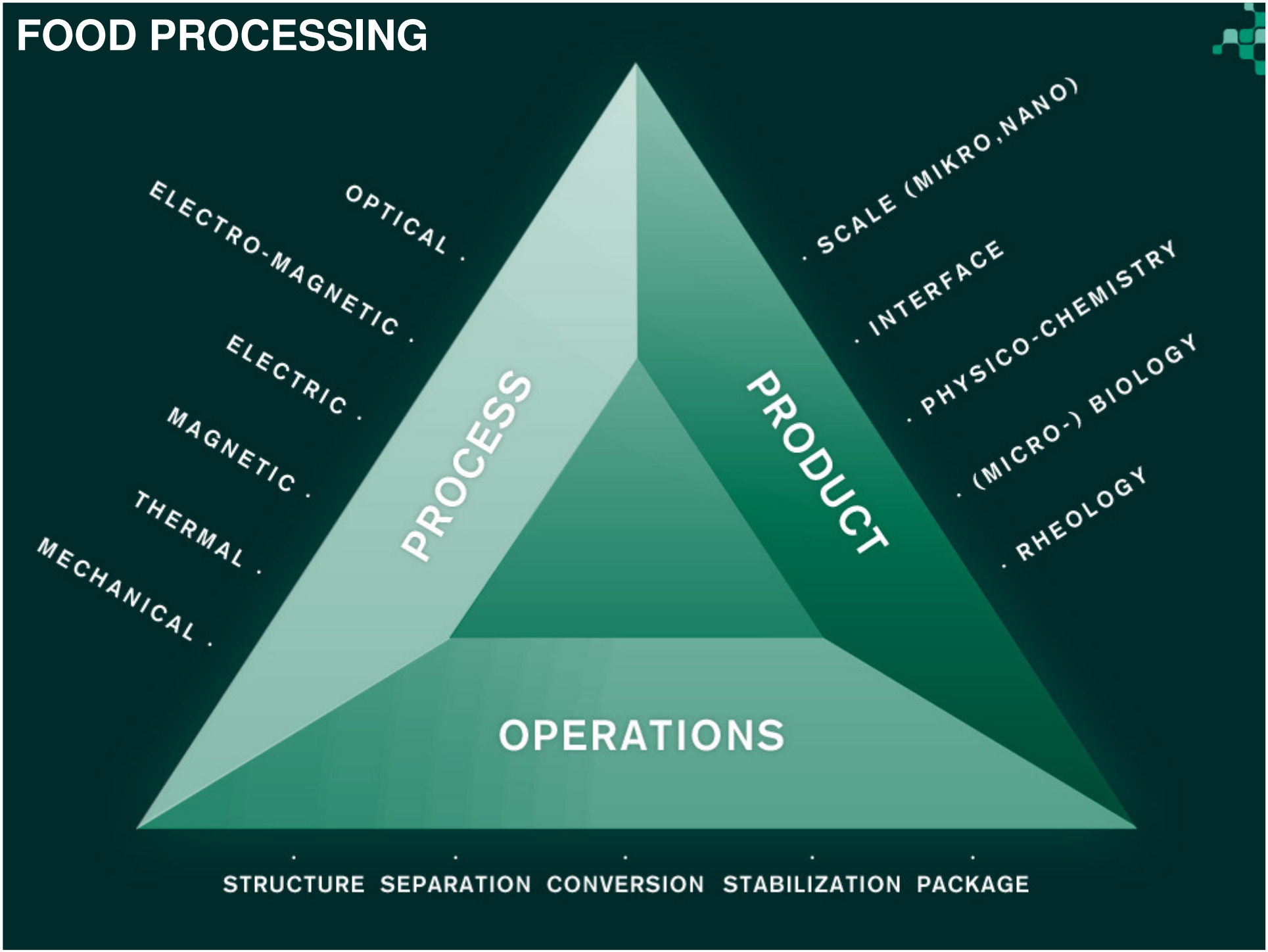
DAIRY CREAM



CHOCOLATE






FOOD PROCESSING
OPTICAL .
ELECTRO-MAGNETIC .
ELECTRIC .
MAGNETIC .
THERMAL .
MECHANICAL .
PROCESS
. SCALE (MIKRO,NANO)
. INTERFACE
. PHYSICO-CHEMISTRY
. (MICRO-) BIOLOGY
. RHEOLOGY
PRODUCT
OPERATIONS
STRUCTURE SEPARATION CONVERSION STABILIZATION PACKAGE

FOOD PROCESSING in EU Projects

Processing Innovation Networks:

HighTech Europe (FP7-NoE) www.hightecheurope.eu, www.foodtech-portal.eu

Recapt (FP7-KBBE) www.recapt.org

Shockwave Processing:

ShockMeat (FP7-KMU) www.shockmeat.eu

Pulsed Electric Fields:

HST FoodTrain (FP7-MC) http://hstfoodtrain-itn.eu

OILPULSE (FP7-KBBE) http://oilpulse.cric-projects.com

SMARTMILK (FP7-SME)

Novel Q (FP6) www.novelq.org

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Packaging:

NAFISPACK (FP7-KBBE) www.nafispack.com

ISA-Pack (FP/-KBBE) www.isapack.eu

SUCCIPACK (FP/-KBBE) www.succipack.eu

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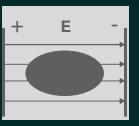
Electromagnetic Processes

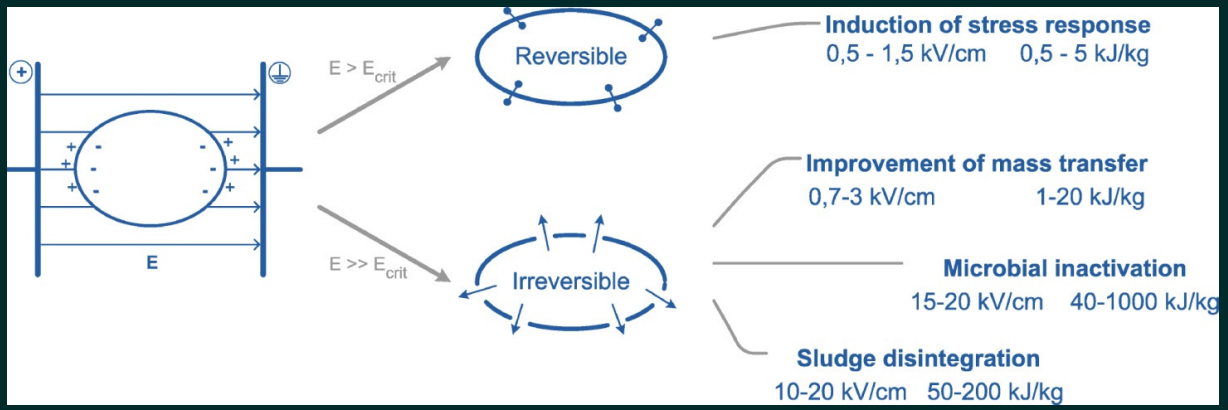
- Pulsed electrical fields
- Electron beam
- Ohmic heating
- Infrared heating
- Cold plasma

Pulsed Electric Field (PEF)

Principle Overview



PEF Principle



PEF preservation

PEF extraction

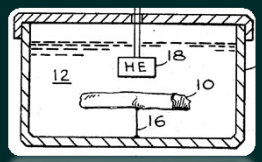
Mechanical Processes

- Extrusion
- Shock waves
- High pressure homogenisation
- Super critical fluid extraction (SCFX)
- Ultrasonic cutting

4. Historical Perspective on Shockwave Technology

1970

Underwater detonation of explosives. (Godfrey)



1993-94

Hydrodyne process
Use of explosives. (Long)

2000

Underwater electrical discharge. (Long)

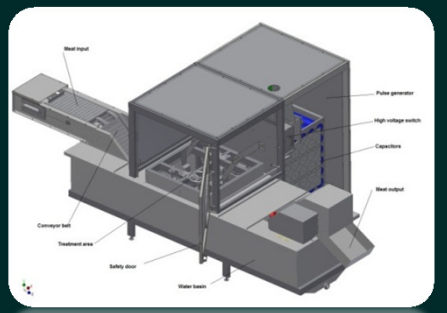
2008-2011

Underwater electrical discharge with wire. Batch-pilot equipment. (Heinz & Toepfl)

2012-13

Underwater electrical discharge without wire and with focused waves. Continuous pilot equipment.

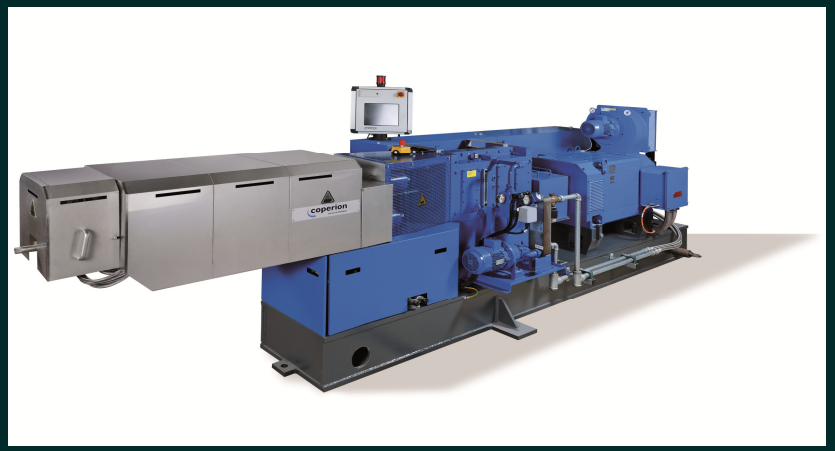
Project website:
www.shockmeat.eu

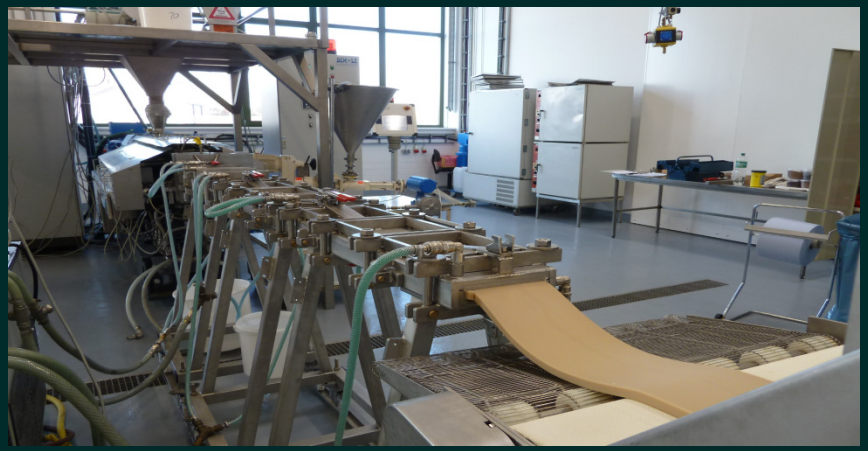


Development a Shockwave Prototype

Wet Extrusion

Meat Analog: Texturized **Fibrillar** Vegetable Protein



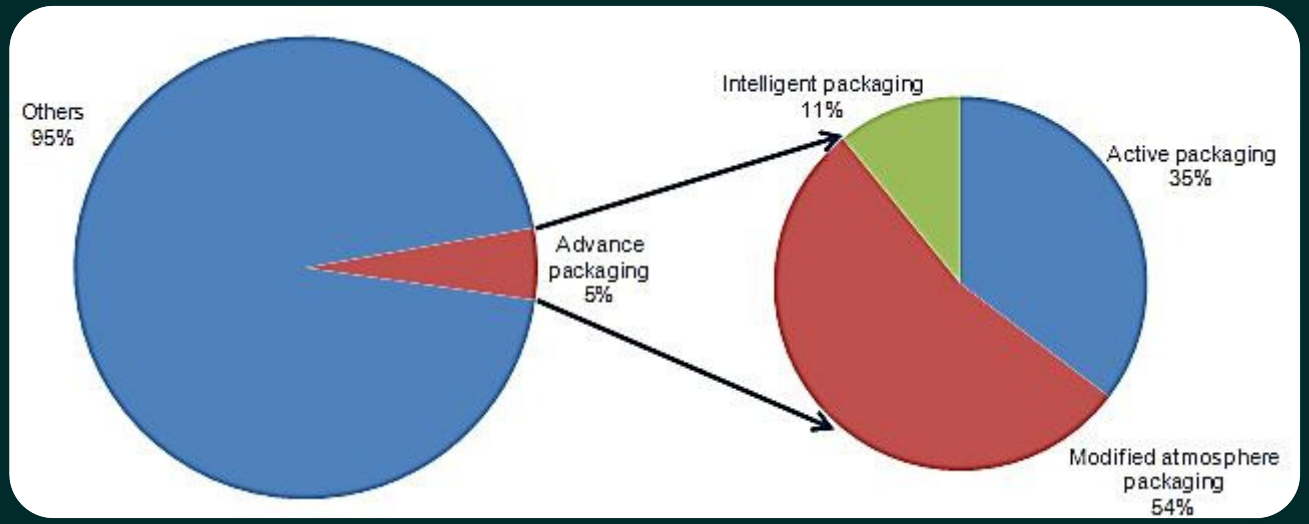


Advanced Packaging Methods

- Edible coatings
- Active packaging
- Intelligent packaging
- Biodegradable packaging film
- RFID

Advanced Packaging Methods

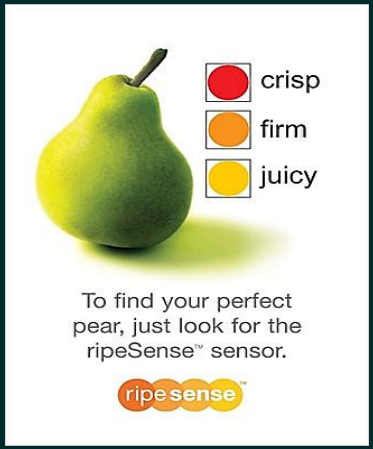
Advanced Packaging Trends



Share of Advanced Packaging Technology Breakup, By Types (2010)

Intelligent Packaging

Freshness Indicators



Packaged golden drop with food spoilage indicator label.
Green = fresh; orange = warning

Status of some Innovative Technologies

- **Pulsed electrical** field PEF processing as liquid pasteurization method is industrialized since 2006
- Pulsed electrical field PEF processing could be combined with spore reduction like cross filtration

- **High Pressure Processing** HPP is already used in industry for multi category products
- High Pressure Processing HPP is mainly used for preservation, but only less for modification

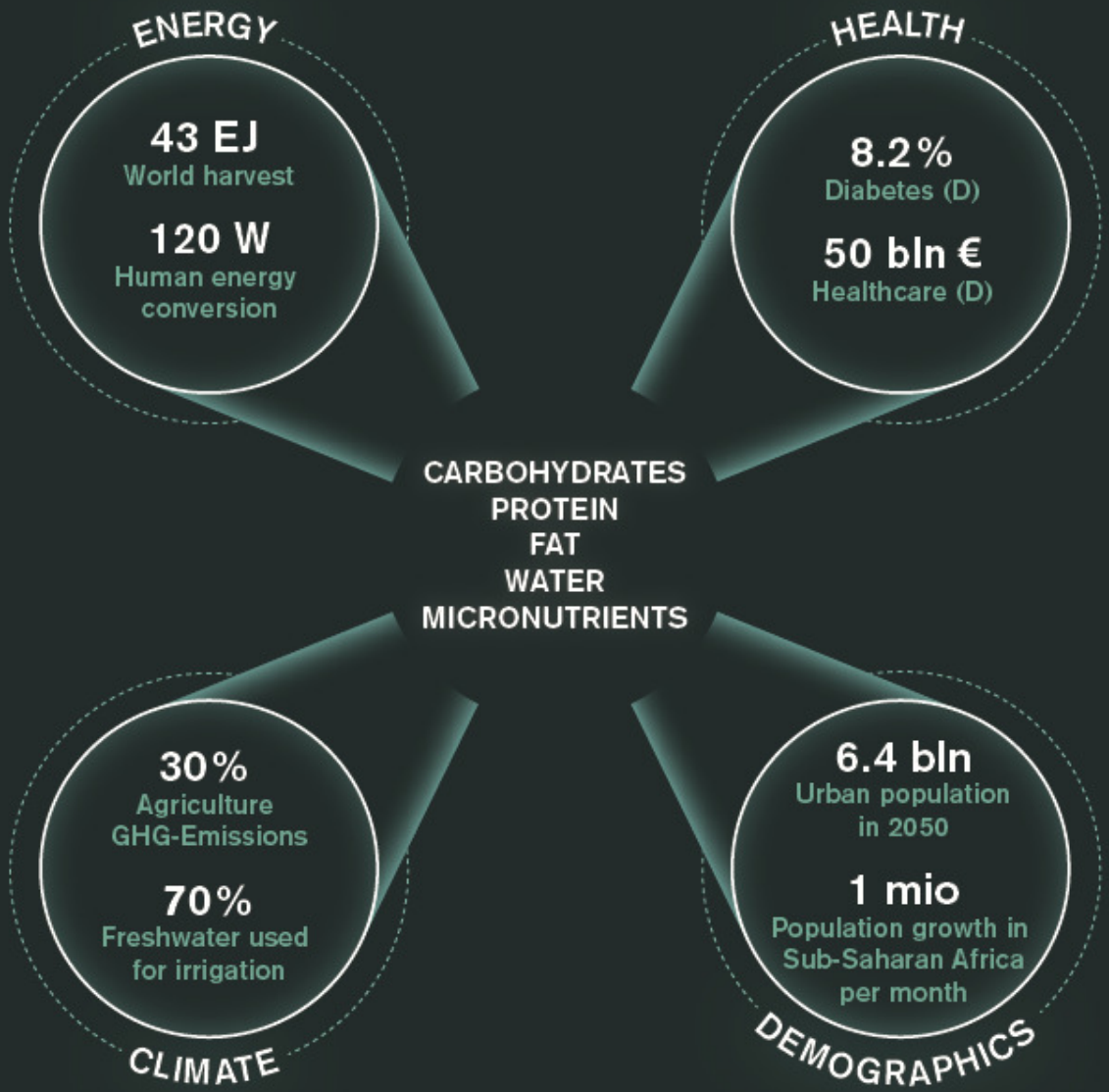
- **Shockwave** treatment can reduce meat maturation from 2 weeks to 2 days

- **Ohmic heating**: dehydration, fermentation blanching, thawing, on-line detection of starch gelatinization, fermentation, peeling, dehydration, and extraction.

- **Irradiation**: food or food ingredient must be labelled

- The concept of intentional migration of substances, like antioxidants and preservatives from the package into the food are new perspectives for the **food packaging** .

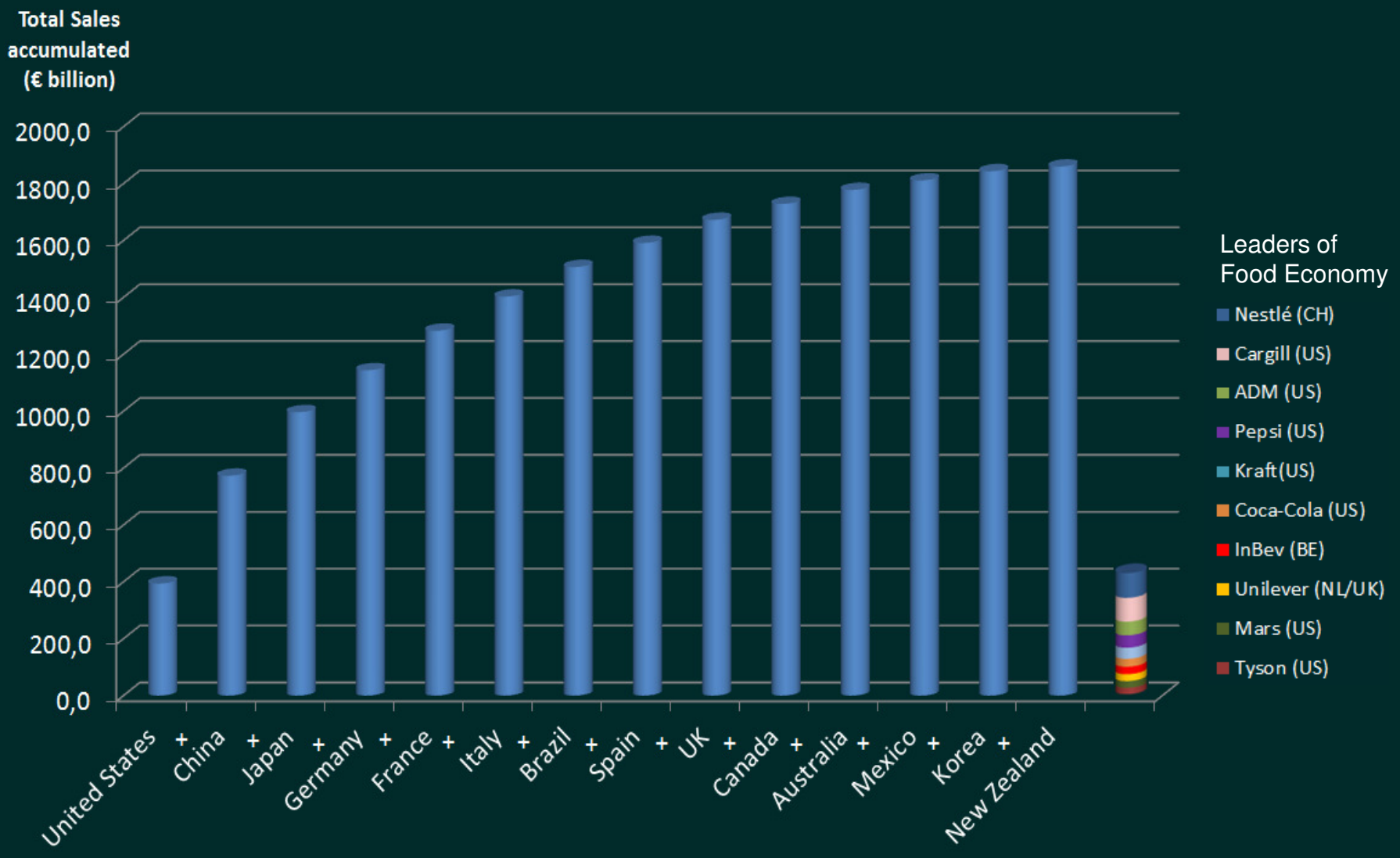
FOOD ASSESSMENT



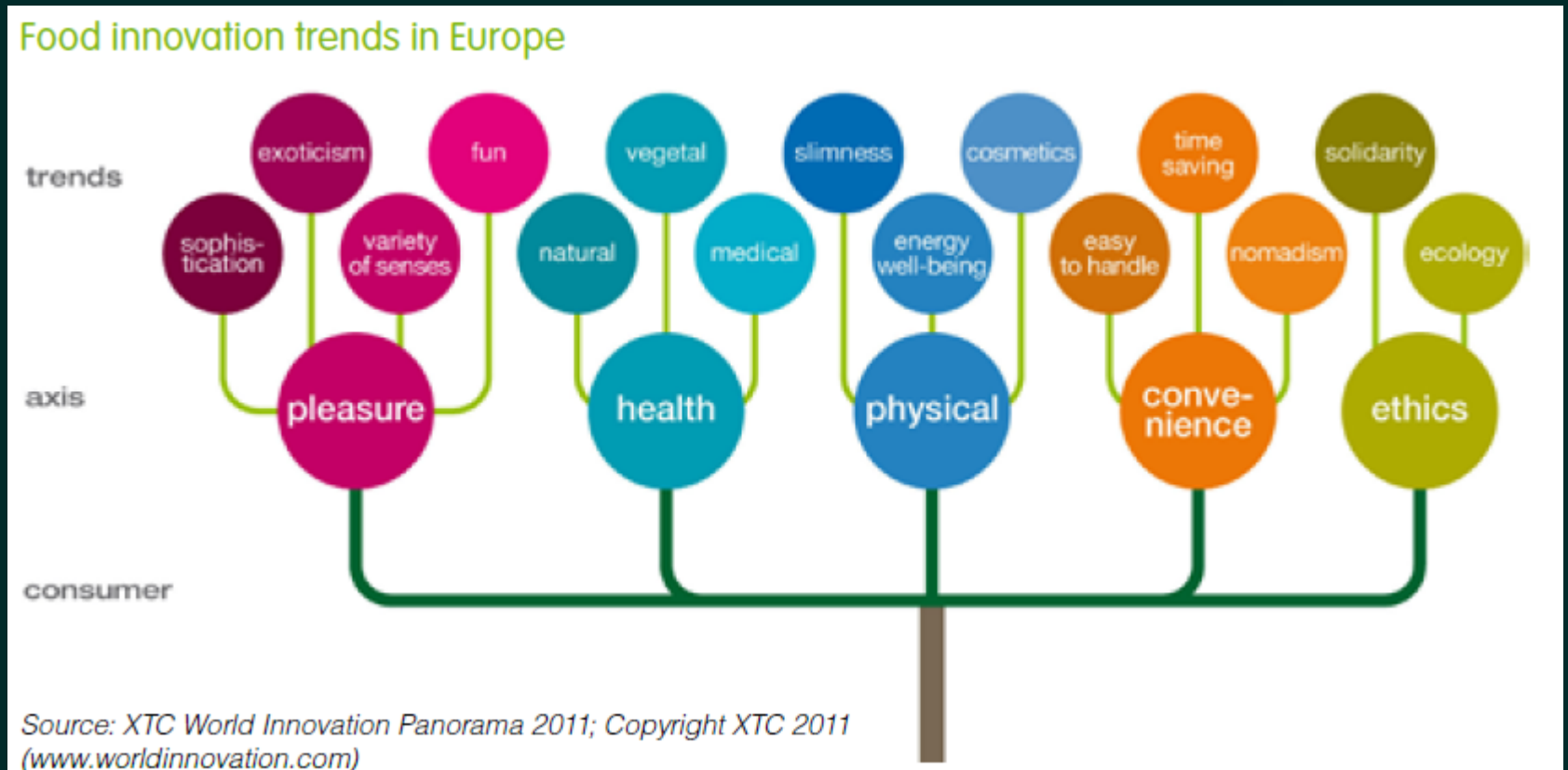
POPULATION – FOOD – ENERGY

	POPULATION (MIO)	GDP BLN ($)	GDP / CAPITA (1,000 $)	ENERGY DEMAND (EJ)	ENERGY/CAPITA (GJ)	AGRI ENERGY (EJ)	FOOD ENERGY DEMAND (EJ)
North America	542	174	32	116	214	0.84	1.82
South America	394	35	9	27	69	0.56	1.32
Europe	740	187	25	122	166	1.44	2.48
Asia	4,165	106	2.5	223	53	3.86	14.0
Africa	1,031	16	1.5	16	15	0.38	3.46
Oceania	29	10	37	6	213	0.17	0.98
Total	6,902	530		512	731	7.21	23.2

FOOD AND DRINK INDUSTRY WORLDWIDE, 2009

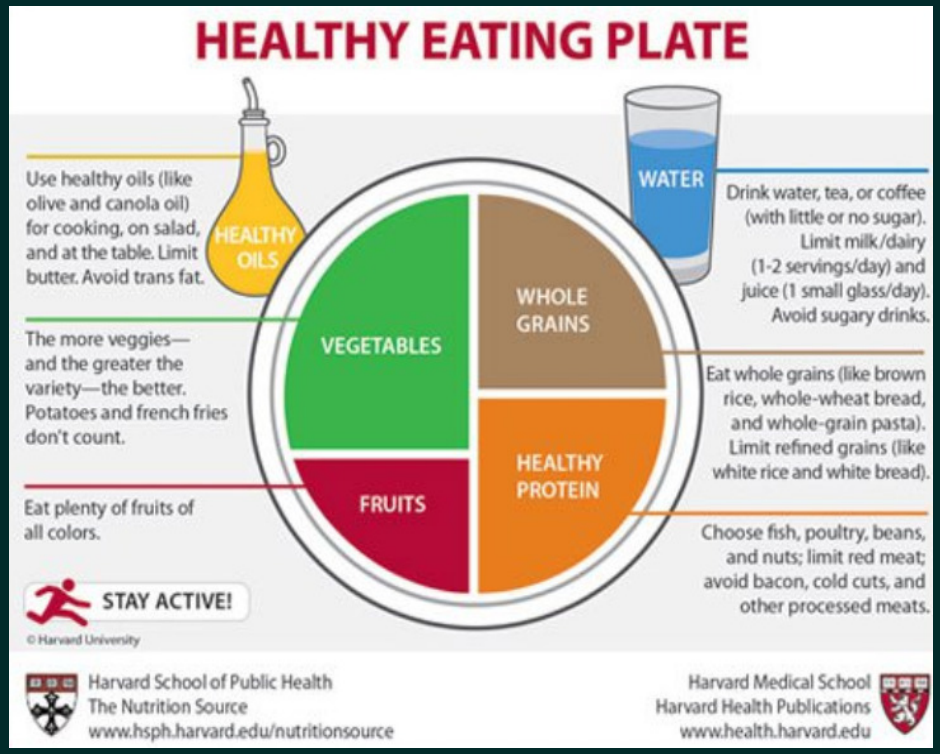


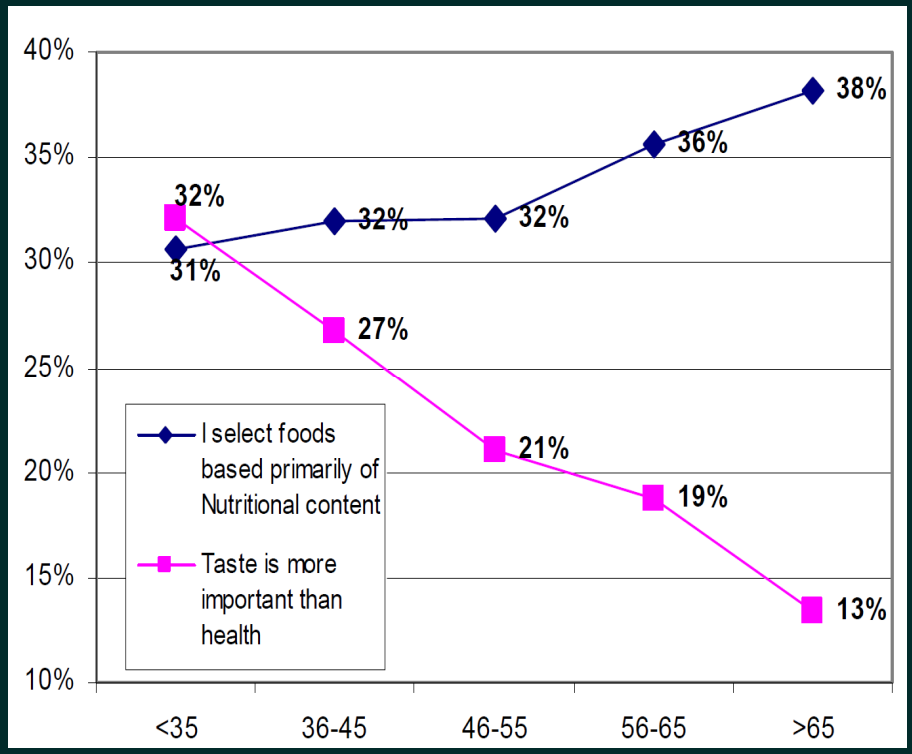
Drivers for Innovation: Health & Wellbeing



	2010	2011
Pleasure	52.2	54.5
Health	22.4	19.9
Convenience	16.6	16.8
Physical	6.5	6.1
Ethics	2.3	2.7

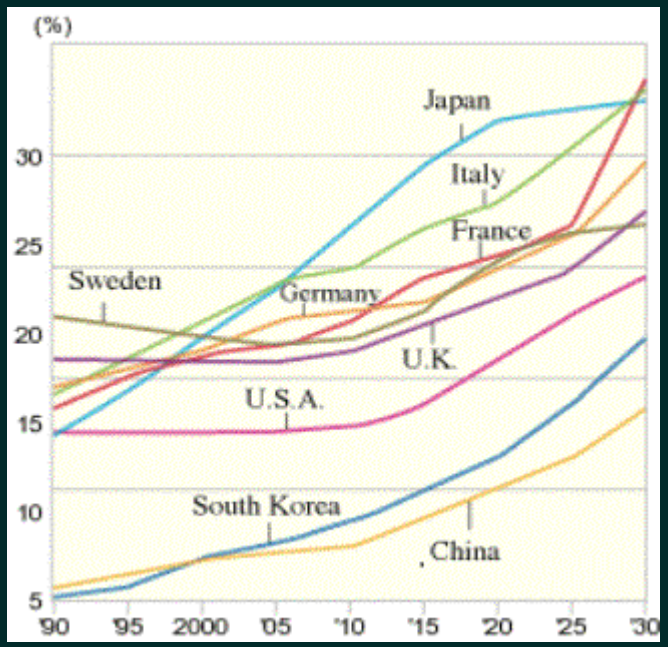
Food for a healthy life





Drivers for Innovation: Demographics

RIBA (Robot for Interactive Body Assistance) from RIKEN-TRI Collaboration Center for Human-Interactive Robot Research(RTC), Japan



Percentage of Population older than 65 (Data from The Australian Network for Universal Housing Design, 2010)

Car-o-bot (third generation)
Product vision of a mobile robot assistant to actively support humans in domestic environments (Fraunhofer IPA, Germany)

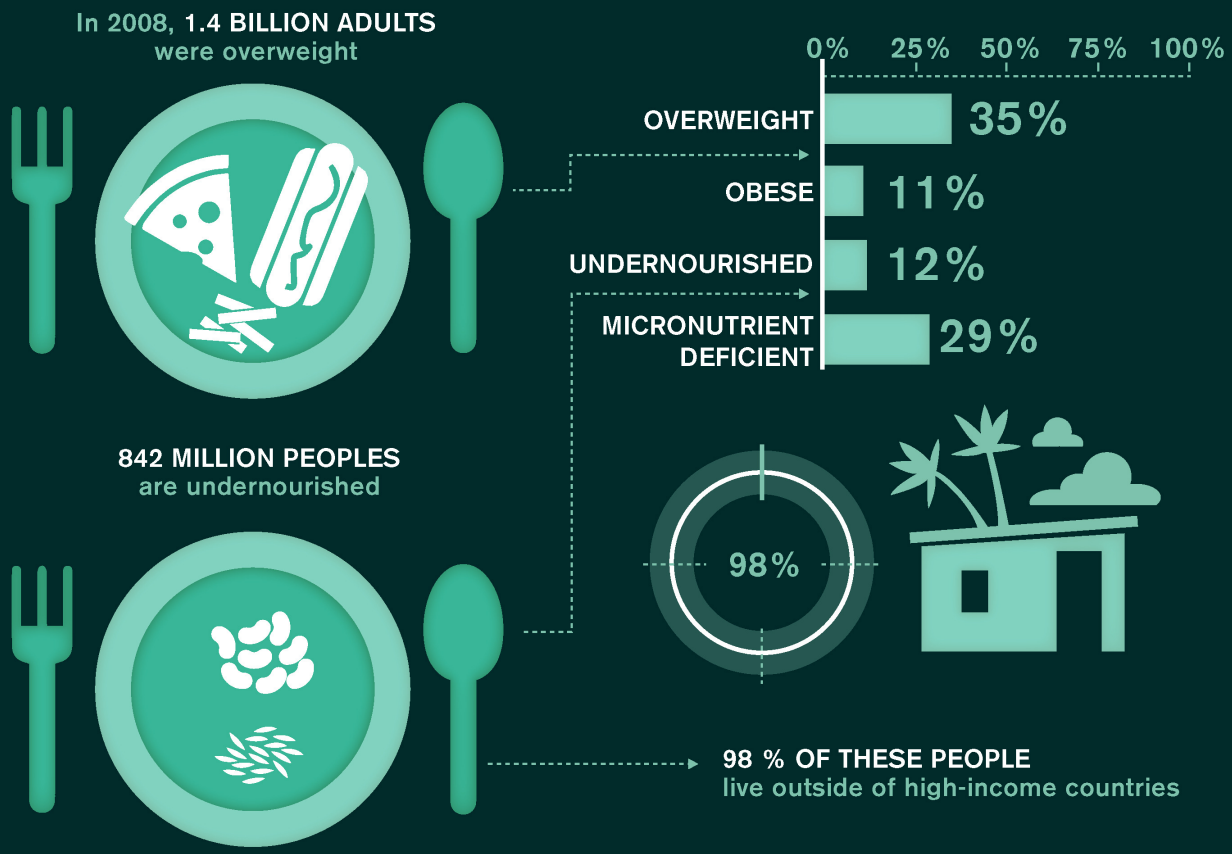
Food for Robot Assistance Systems

Challenges:

- Texture
- Taste Varieties
- Shelf Life
- Packaging
- Storage

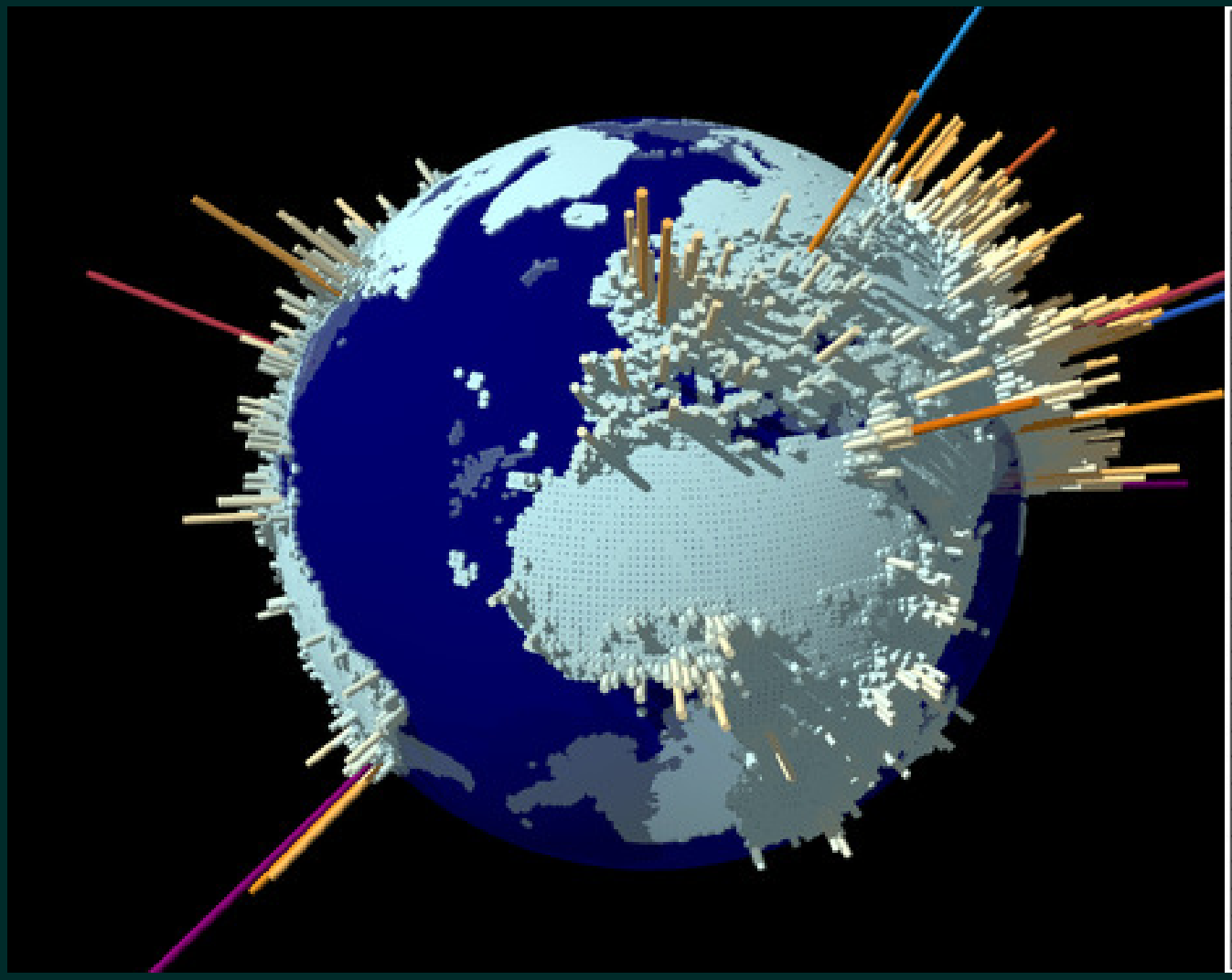
Allowing a largely self determined life for handicaped persons

Drivers for Innovation: Health & Hunger



Source: FAO, 2013 / WHO, 2012

Drivers for Innovation: Urbanization



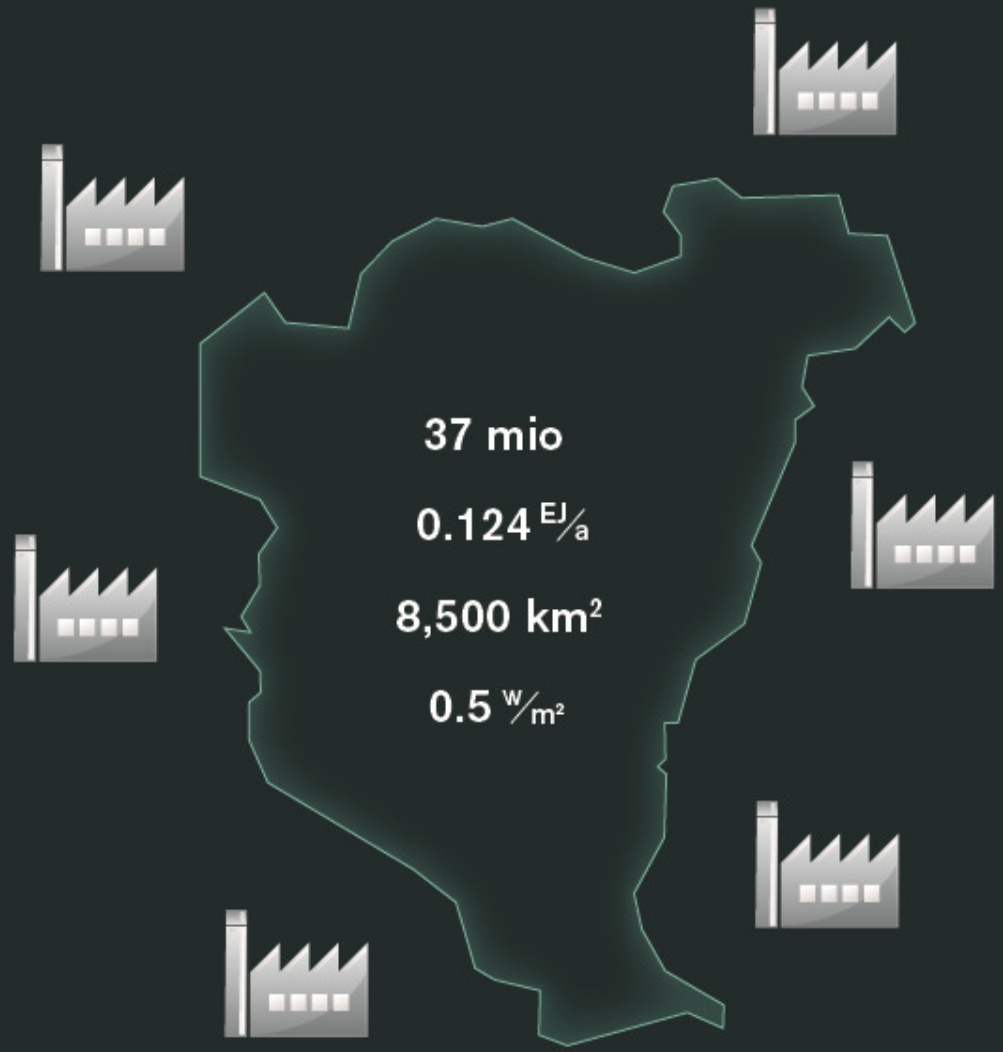
	Country/City/Company	GDP/Revenues
1	United States	14,204
2	China	7,903
3	Japan	4,354
4	India	3,388
5	Germany	2,925
6	Russian Federation	2,288
7	United Kingdom	2,176
8	France	2,112
9	Brazil	1,976
10	Italy	1,840
11	Mexico	1,541
12	Tokyo, Japan	1,479
13	Spain	1,456
14	New York, USA	1,406
15	Korea, Republic of	1,358
16	Canada	1,213
17	Turkey	1,028
18	Indonesia	907
19	Iran, Islamic Rep	839
20	Los Angeles, USA	792
21	Australia	762
22	Taiwan	710
23	Netherlands	671
24	Poland	671
25	Saudi Arabia	589
26	Chicago, USA	574
27	Argentina	571
28	London, UK	565
29	Paris, France	564
30	Thailand	519
31	South Africa	492
32	Royal Dutch Shell	458
33	Egypt, Arab Rep	441
34	Pakistan	439

MEGA CITIES

	POPULATION	PERCENTAGE OF MOTORISED PUBLIC MODES OVER ALL TRIPS	PERCENTAGE OF MOTORISED PRIVATE MODES OVER ALL TRIPS	TOTAL TRANSPORT ENERGY USE PER CAPITA (MJ/PERSON)	EMISSION OF NOx PER CAPITA (KG/PERSON)	URBAN DENSITY (PERSON/HA)	GROSS DOMESTIC PRODUCT OF THE METROPOLITAN AREA PER CAPITA
Bankok	14.544.000	43	46		21	139	6316
Beijing	18.241.000	27	24		11	123	1829
Berlin	3.956.000	24	44	13	6	56	23480
Chicago	9.104.000	4	85		10	17	32110
Ho Chi Minh City	8.764.000	2	54		2	356	1029
Jakarta	26.746.000	25	28		11	173	1862
London	9.576.000	16	49	16	16	59	22363
New York	20.673.000	9	75		21	18	34395
Sao Paulo	20.568.000	33	32	6	16	78	5319
Singapur	5.287.000	31	53	21	18	94	28578
Tokyo	37.239.000	31	32	7	4	88	45425

Source: Sustainability and Cities, Concept and Assessment, Ooi Giok Ling, 2005

FOOD FOR MEGA CITIES



TOKIO

DHAKA

Production approaching Consumption

The New York City Council
Christine C. Quinn, Speaker

FoodWorks
A Vision to Improve NYC's Food System

PROCESSING

GOAL 3: ***Generate growth and employment in the food manufacturing sector.***

STRATEGY: ***Make affordable space available.***

Proposals:
- Build a commercial kitchen incubator for start-ups.
- Develop new industrial space for food manufacturing businesses.
- Revitalize New York City's market system through the New Yorkers 4 Markets initiative.

STRATEGY: ***Provide technical assistance to food manufacturers.***

Proposals:
- Create an online resource center for food manufacturers.
- Establish a workshops series to assist food manufacturers.

GOAL 4: ***Increase regional products processed in and for New York City.***

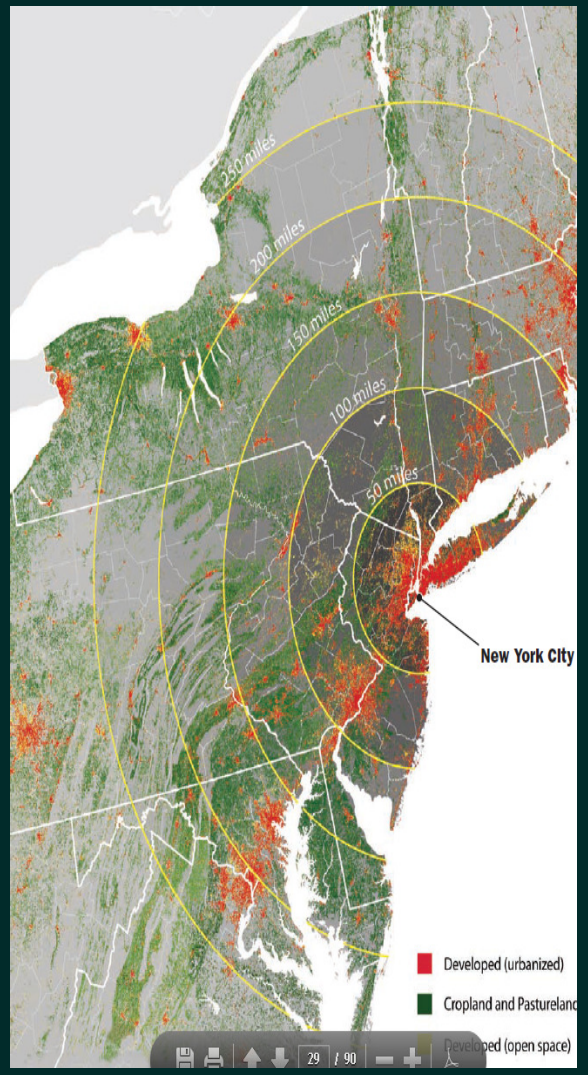
STRATEGY: ***Facilitate urban-rural linkages.***

Proposal:
- Hold a regional food business-to-business (B2B) conference.

GOAL 5: ***Reduce the environmental impact associated with food processing in New York City.***

STRATEGY: ***Help businesses reduce energy consumption.***

Proposal:
- Help food manufacturers access energy efficiency programs.



Urban Food Production

Rooftop Vegie Production

Fassade Algea Cultivation

Kitchen Garden

First Lady Michelle Obama harvests vegetables with students in the White House Kitchen Garden on the South Lawn, May 28, 2013. (Official White House Photo by Chuck Kennedy)

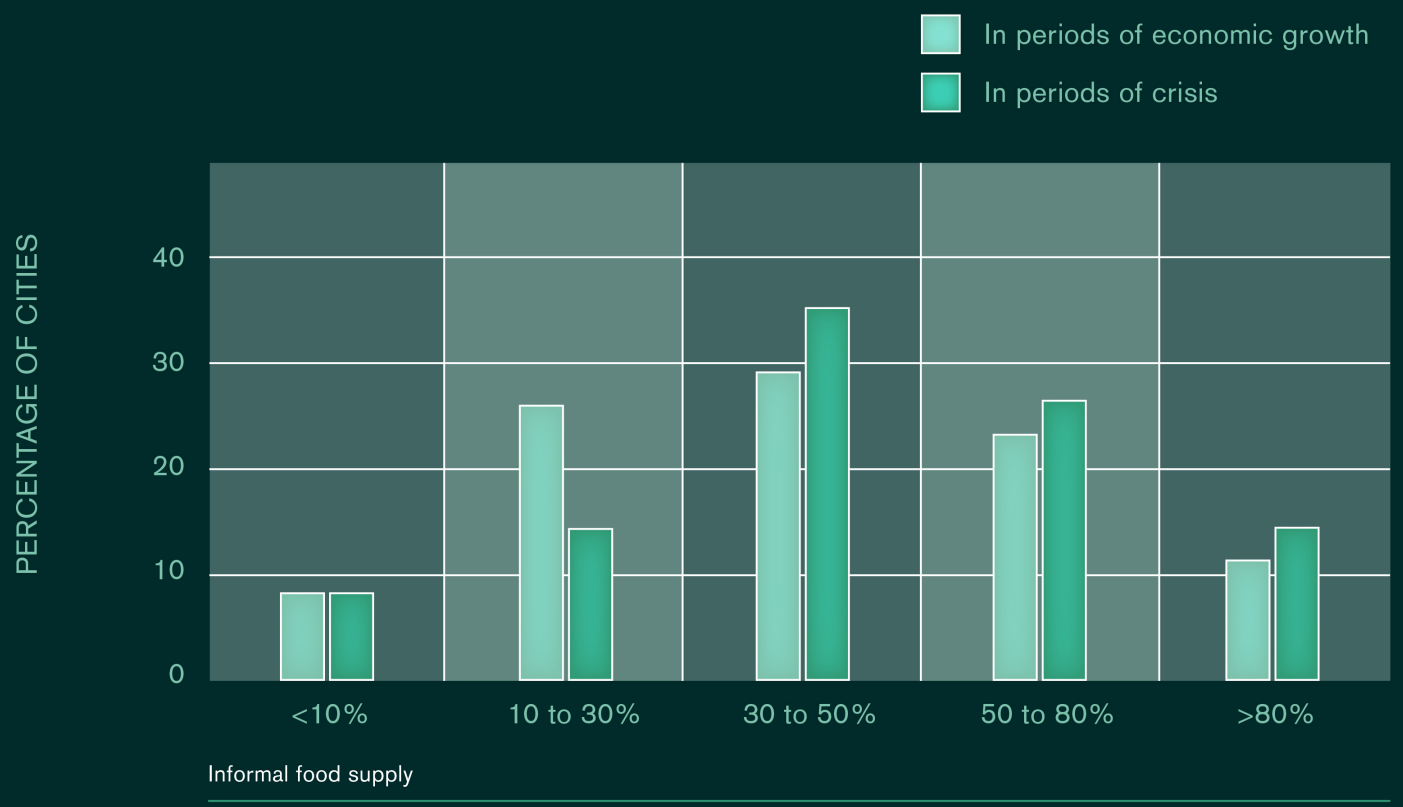
Urban Lifestock

FOOD FOR MEGA CITIES

URBAN AREA	POPULATION ESTIMATE	LAND AREA: KM²	DENSITY	DAILY FOOD ENERGY DEMAND, MJ	AGRICULTURAL AREA, HA	AGRICULTURAL AREA, KM²
Tokyo-Yokohama	37.239.000	8,547	4,4	389.799.233	1.226.523	12.265
Seoul-Incheon	22.868.000	2,163	10,6	239.370.790	753.193	7.532
Delhi, DL-HR-UP	22.826.000	1,943	11,8	238.931.155	751.809	7.518
New York, NY-NJ-CT	20.673.000	11,642	1,8	216.394.628	680.897	6.809
Beijing, BJ	18.241.000	3,497	5,2	190.937.668	600.795	6.008
Dhaka	14.399.000	324	44,5	150.721.533	474.253	4.743
Lagos	12.090.000	907	13,3	126.552.075	398.203	3.982
London	9.576.000	1,623	5,9	100.236.780	315.400	3.154
Lima	9.400.000	648	14,5	98.394.500	309.603	3.096

Data Source: Demographia World Urban Areas: 9th Annual Edition (2013.03), FAO, 2004

INFORMAL FOOD MARKET IN DEVELOPING COUNTRIES



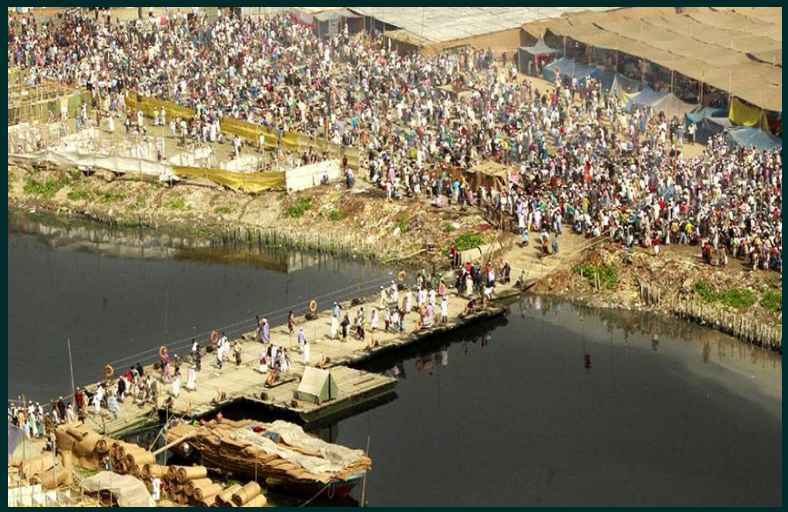
Source: Hugon and Kervarec, 2001

FAO, 2007

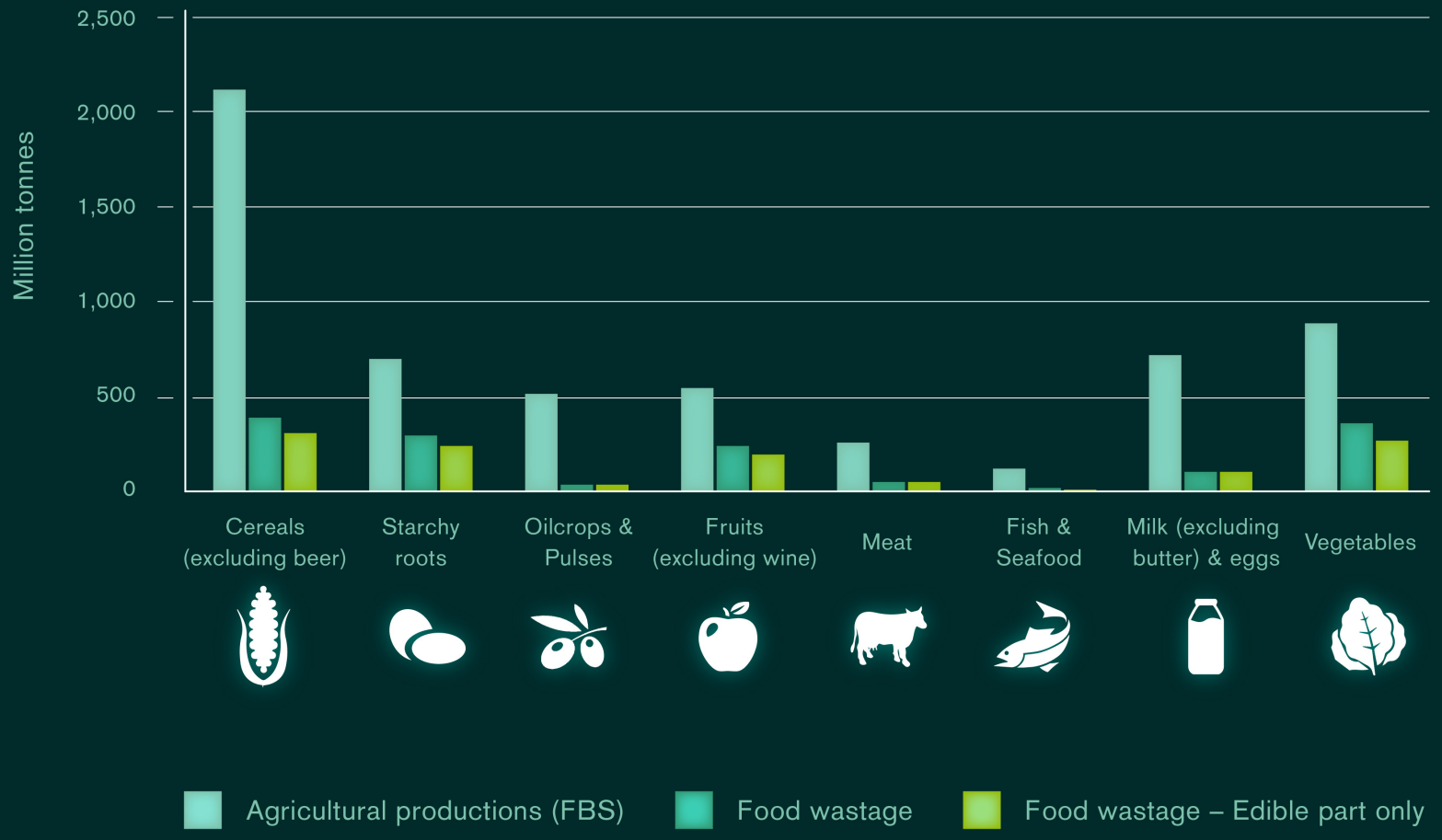
In some African cities informal market reach 40-60%.

Food Logistics

Food Trade , Production

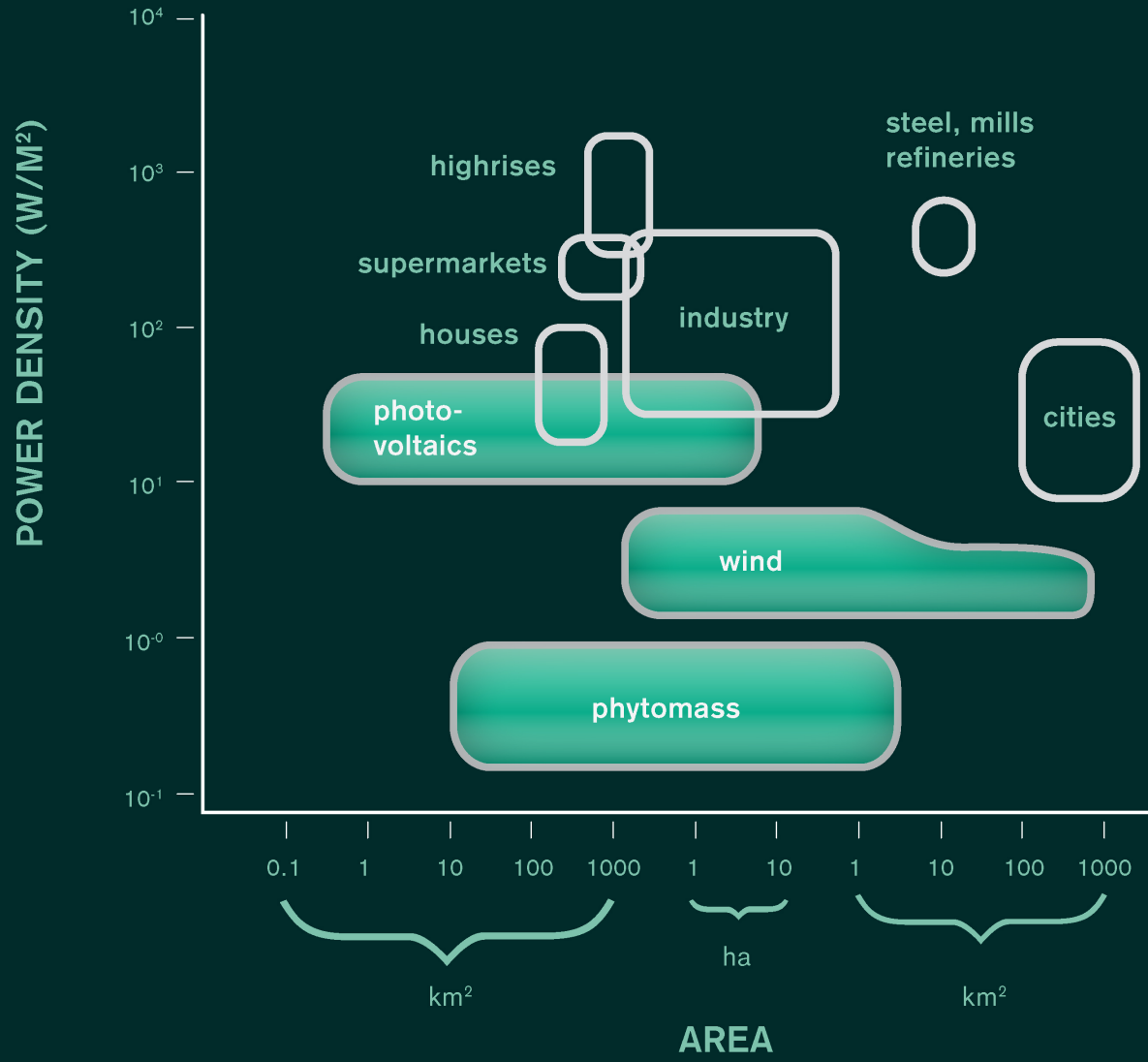


AGRICULTURAL PRODUCTION VOLUME VS. FOOD WASTAGE VOLUME



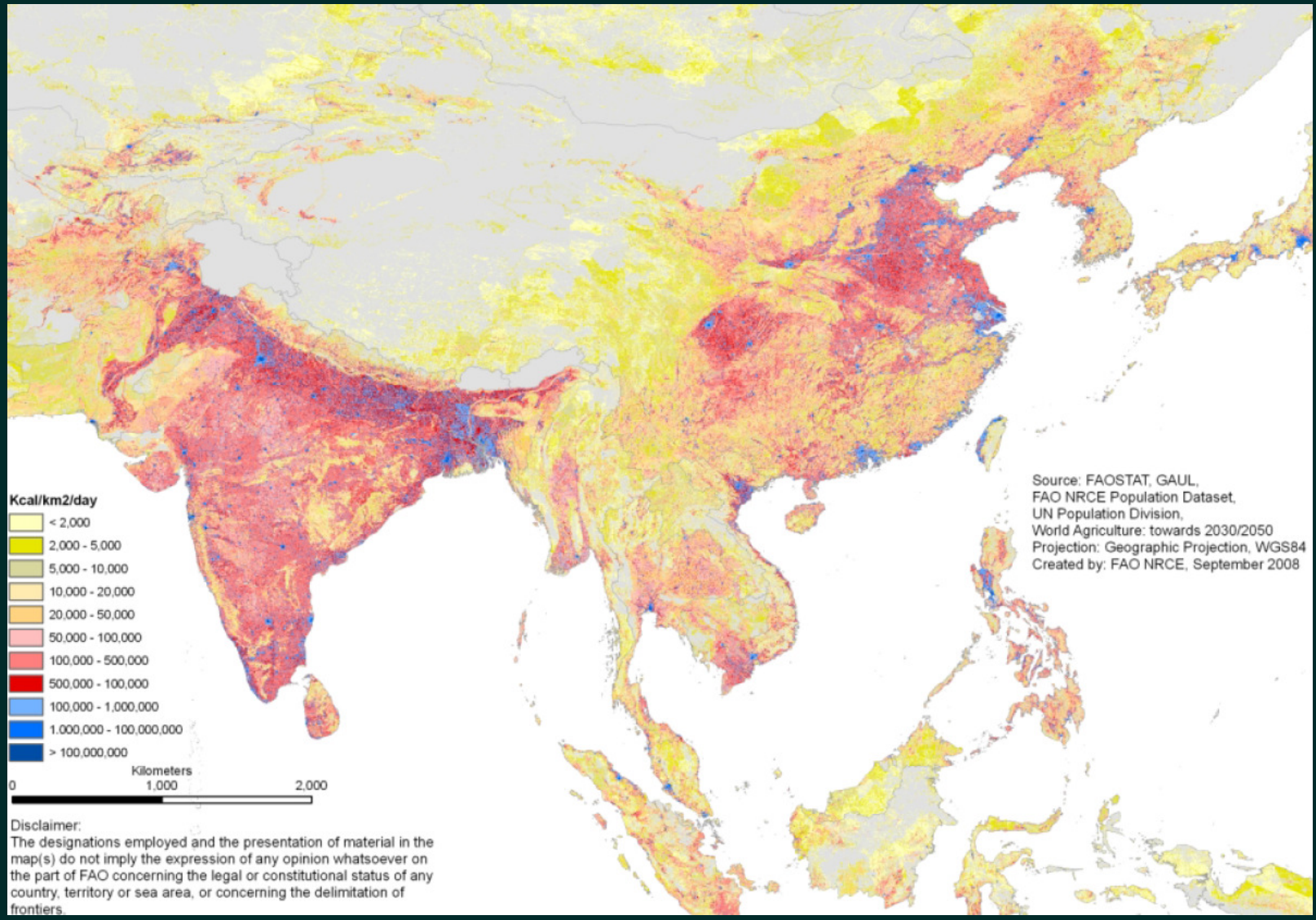
FAO,2013

MISMATCH OF TYPICAL POWER DENSITIES OF RENEWABLE ENERGY CONVERSIONS AND COMMON ENERGY USES IN MODERN SOCIETIES

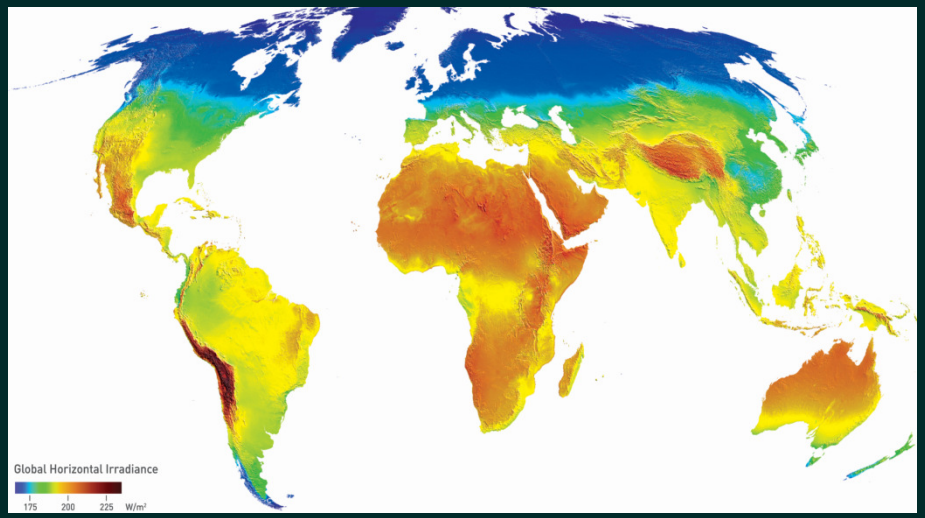


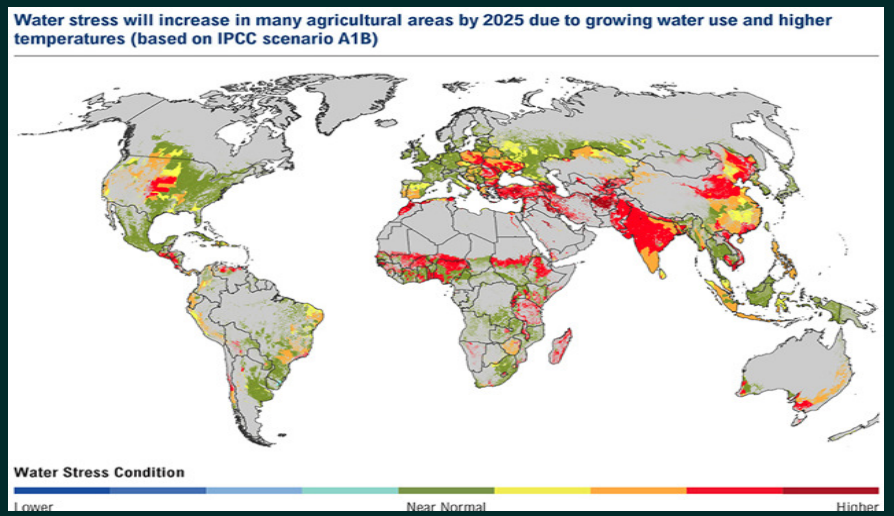
Source: Vaclav Smil, Energy in Nature and Society, 2008, page 383

Extreme Food Calorie Demand in Urban Agglomerates

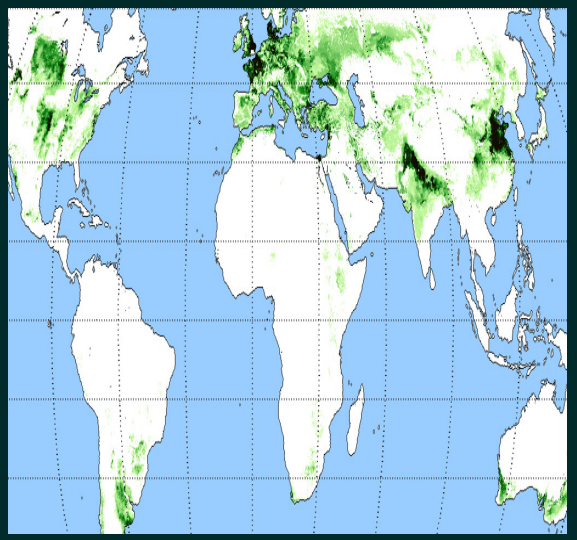


SUN + WATER

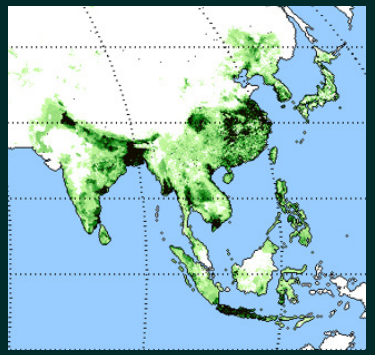




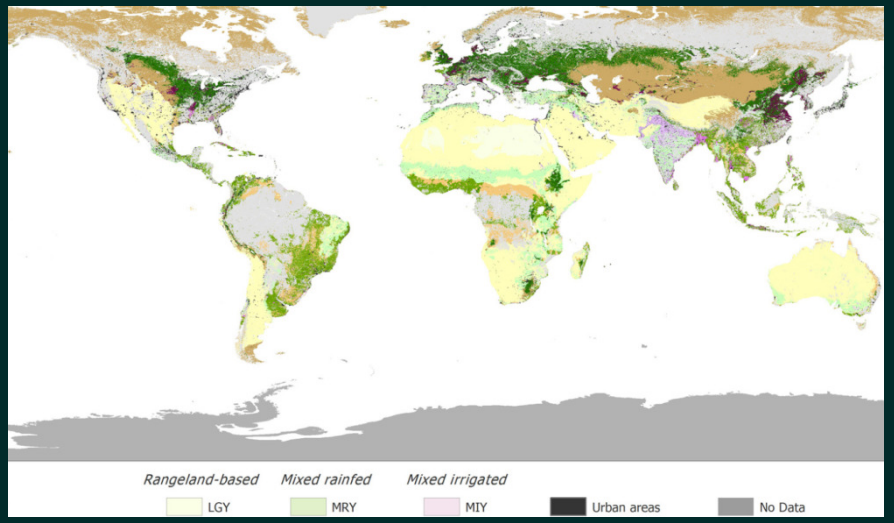
WHEAT

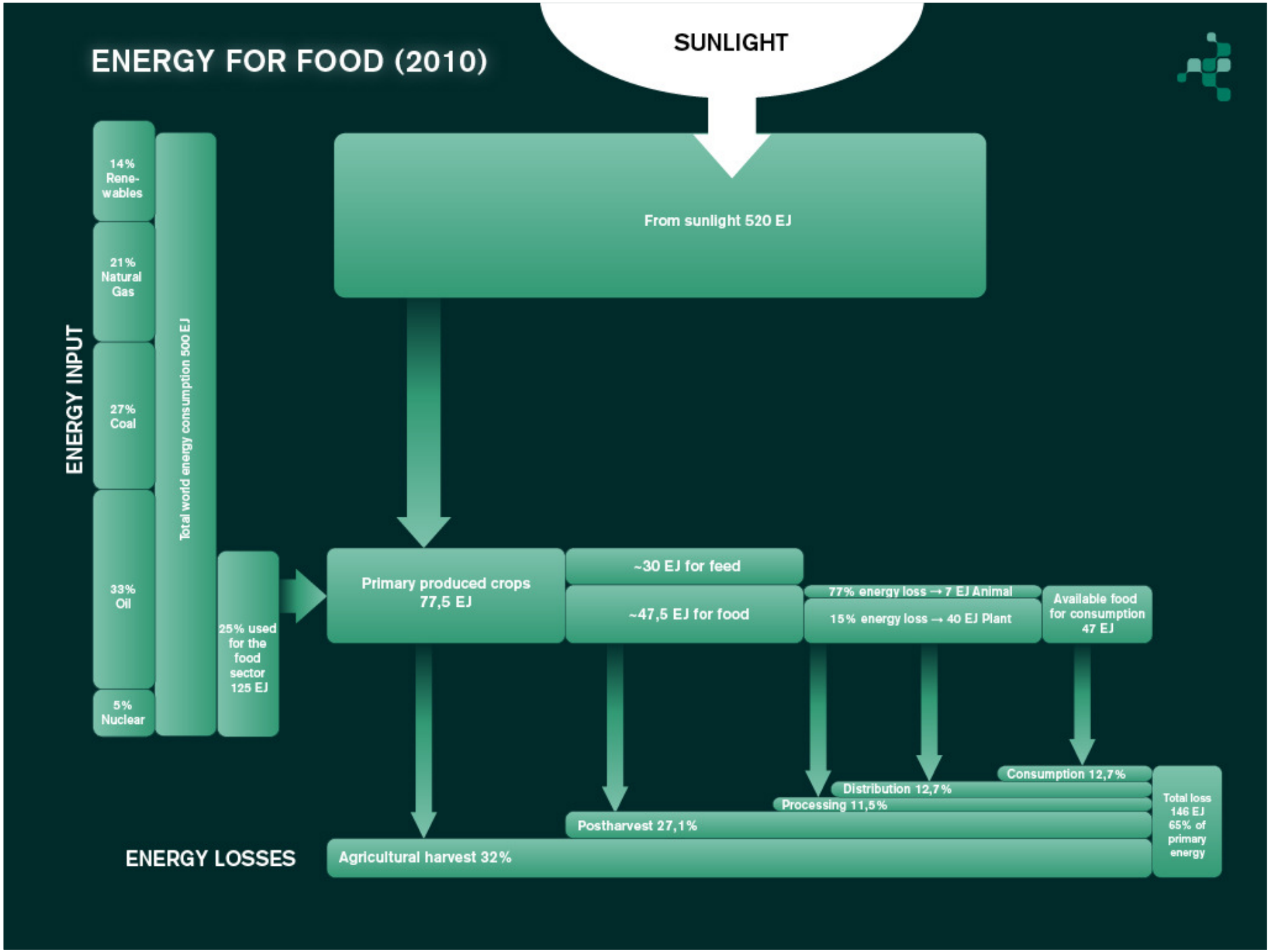


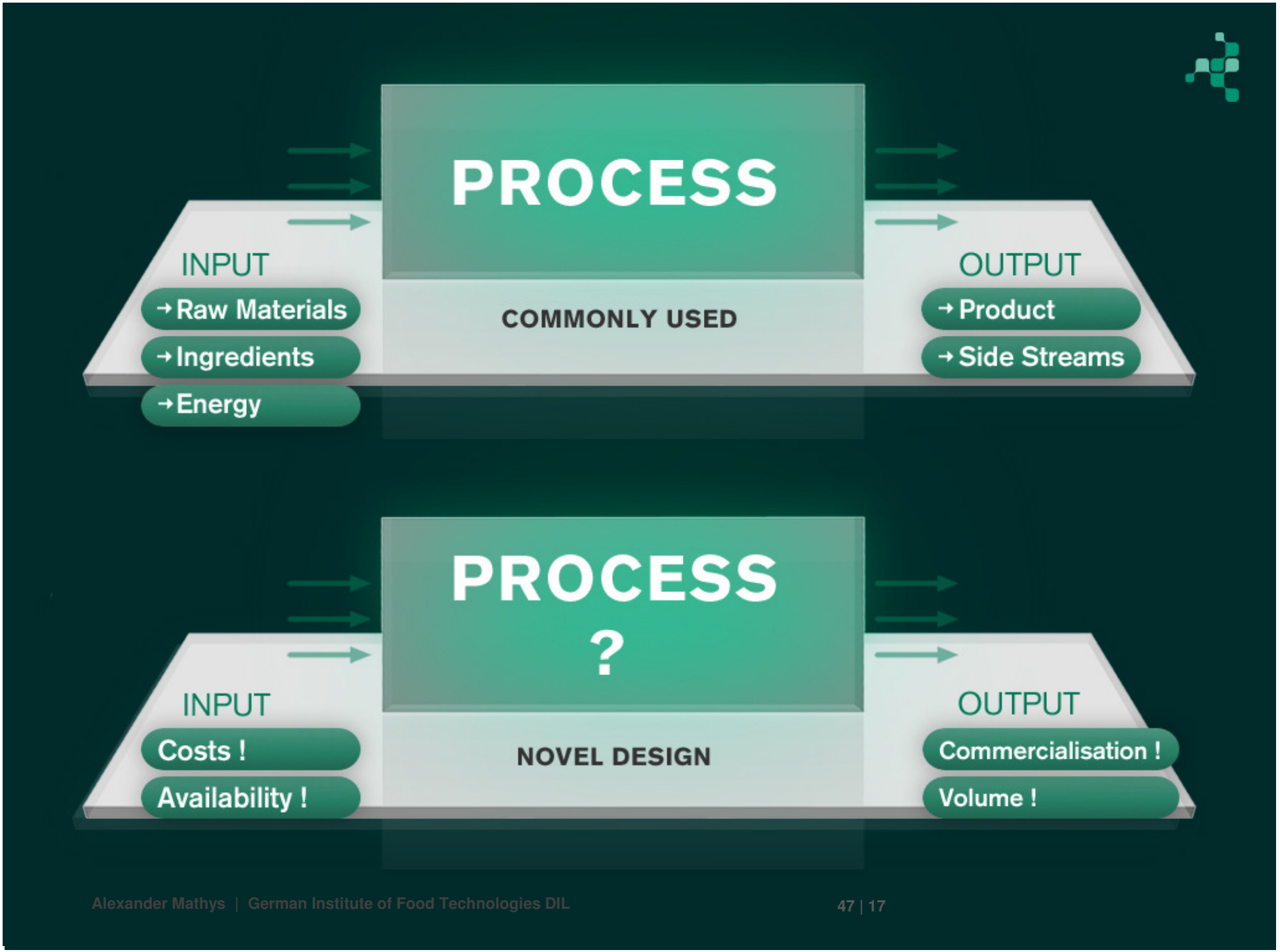
RICE



LIFESTOCK PROD. SYS.

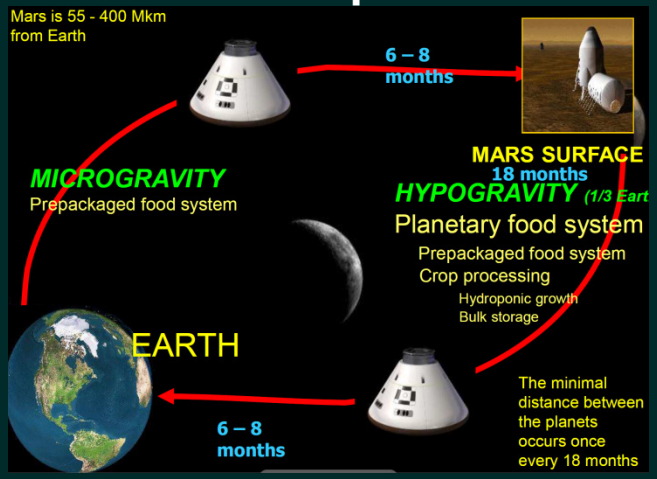


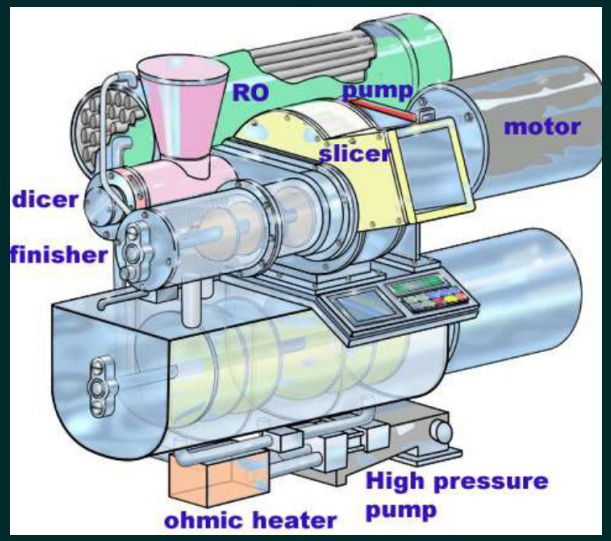

ENERGY FOR FOOD (2010)
SUNLIGHT
From sunlight 520 EJ
ENERGY INPUT
14% Rene-wables
21% Natural Gas
27% Coal
33% Oil
5% Nuclear
Total world energy consumption 500 EJ
25% used for the food sector 125 EJ
Primary produced crops 77,5 EJ
~30 EJ for feed
~47,5 EJ for food
77% energy loss → 7 EJ Animal
15% energy loss → 40 EJ Plant
Available food for consumption 47 EJ
Consumption 12,7%
Distribution 12,7%
Processing 11,5%
Postharvest 27,1%
Agricultural harvest 32%
Total loss 146 EJ 65% of primary energy
ENERGY LOSSES

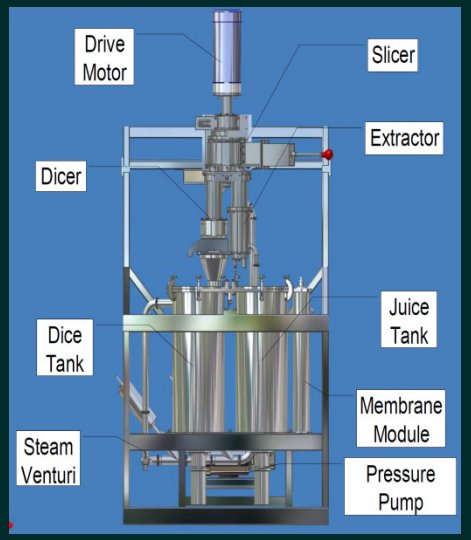

PROCESS
INPUT
→ Raw Materials
→ Ingredients
→ Energy
COMMONLY USED
OUTPUT
→ Product
→ Side Streams
PROCESS
?
INPUT
Costs !
Availability !
NOVEL DESIGN
OUTPUT
Commercialisation !
Volume !

Drivers for Innovation:
Small-Scale Food Production Systems

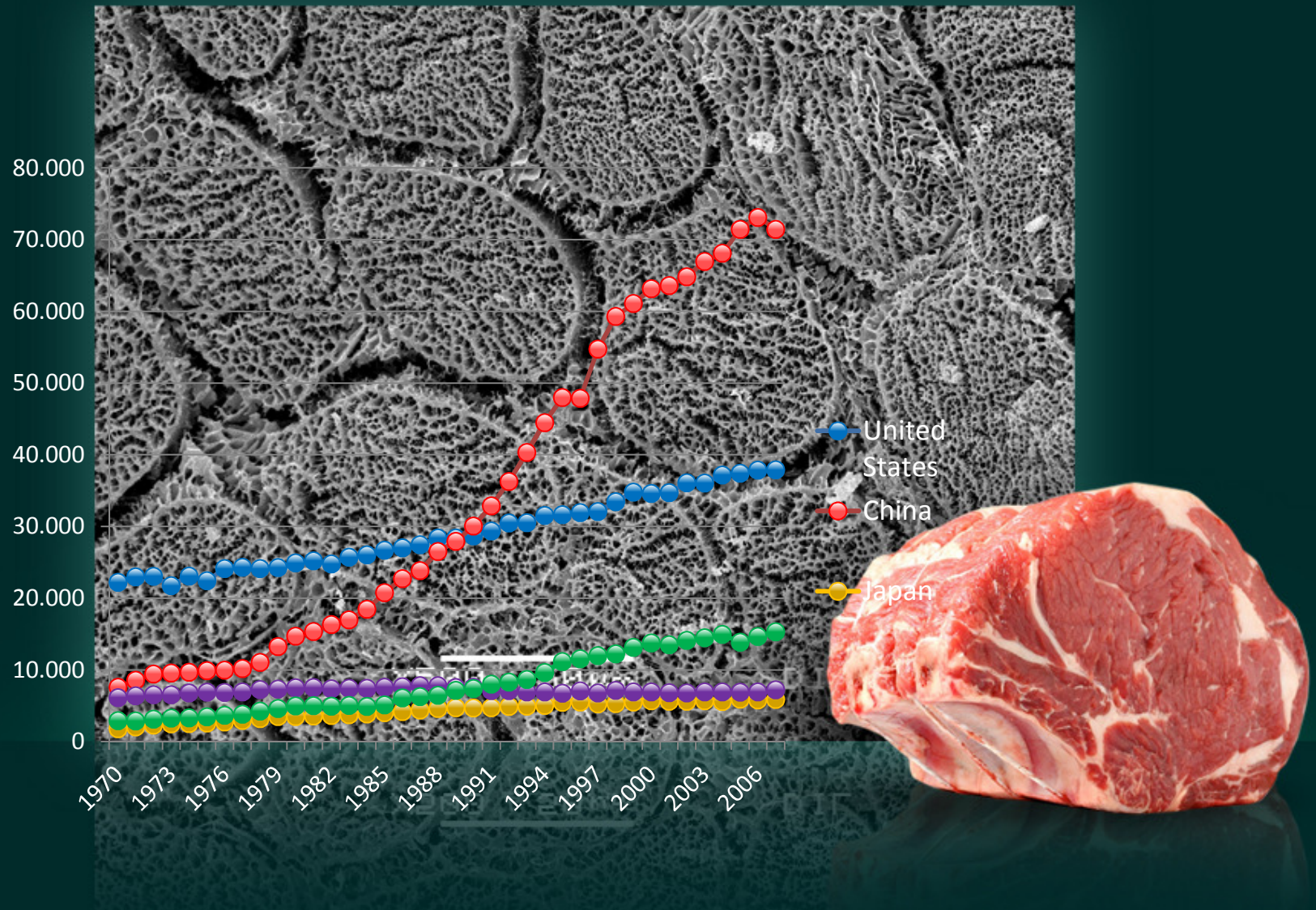
Example: Manned Mars Space Mission





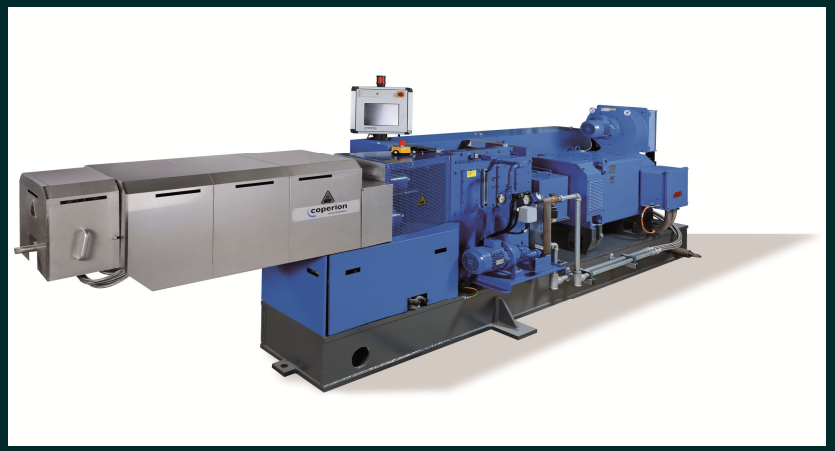


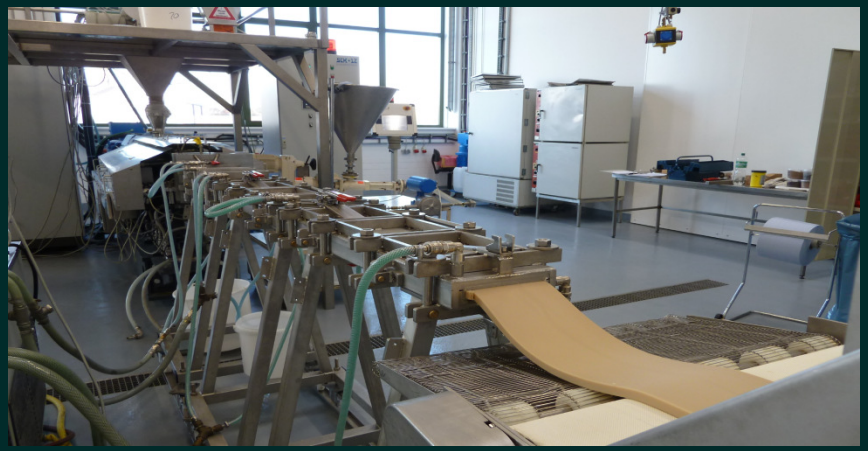
Seeking for Innovation: Global Meat Demand



Analog Meat Structures

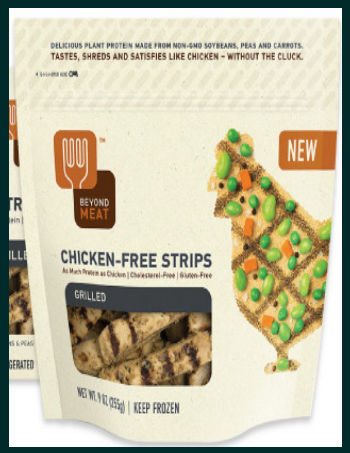
Are these structures attractive enough for status driven consumers in emerging economies?





LIKE MEAT

BEYOND MEAT



COMPARISON OF LCA RESULTS OF MOST KNOWN MEAT SUBSTITUTES

PRODUCT	GLOBAL WARMING, KG CO_2 EQ. / KG	LAND USE / OCCUPATION, M^2 / KG	NON-RENEWABLE ENERGY USE, MJ / KG
(1) Chicken	5.21	3.89	63.6
(2) Dairy based	4.38	3.41	59.1
(3) Lab-grown	23.8	0.385	372.0
(4) Insect based	2.7	1.51	38.1
(5) Gluten based	3.38	5.45	46.2
(6) Soymeal based	2.55	1.07	35.7
(7) Myco-protein based	4.81	0.25	69.0

Smetana et al, 2014

Challenges of food processing

- Innovative Food Structures
- New Taste and Flavors for Global Consumers
- Increased Long-Term Stability (Better Quality - Less Waste)
- Short-Term Stability in Urban Production Schemes
- Adjusted Energy & Nutrient Density of Foods
- High Quality Foods with Reduced Low Impact on Ressources