



# Pacific Rim

Summit on Industrial  
Biotechnology and Bioenergy

October 10-12, 2012  
Vancouver, Canada

*Thursday, October 11, 2012 Time: 4:00pm - 5:30pm*

## **Microalgae: Advancing to Commercial Applications**

*Moderator (and speaker):*

**John Benemann**, MicroBio Engineering, Inc. CA, USA

*Speakers:*

**Stan Barnes**, Bioalgene, WA, USA

**Shay L. Simpson**, Texas AgriLife Research - Texas  
A&M University System, TX, USA

**Amit Vasavada**, General Atomics, CA, USA

**Kirsten Heimann**, James Cook University, Queensland,  
Australia

# Breakout Session Overview:

**John Benemann**, CEO, MicroBio Engineering, CA, review of global R&D activities in microalgae commodities production.

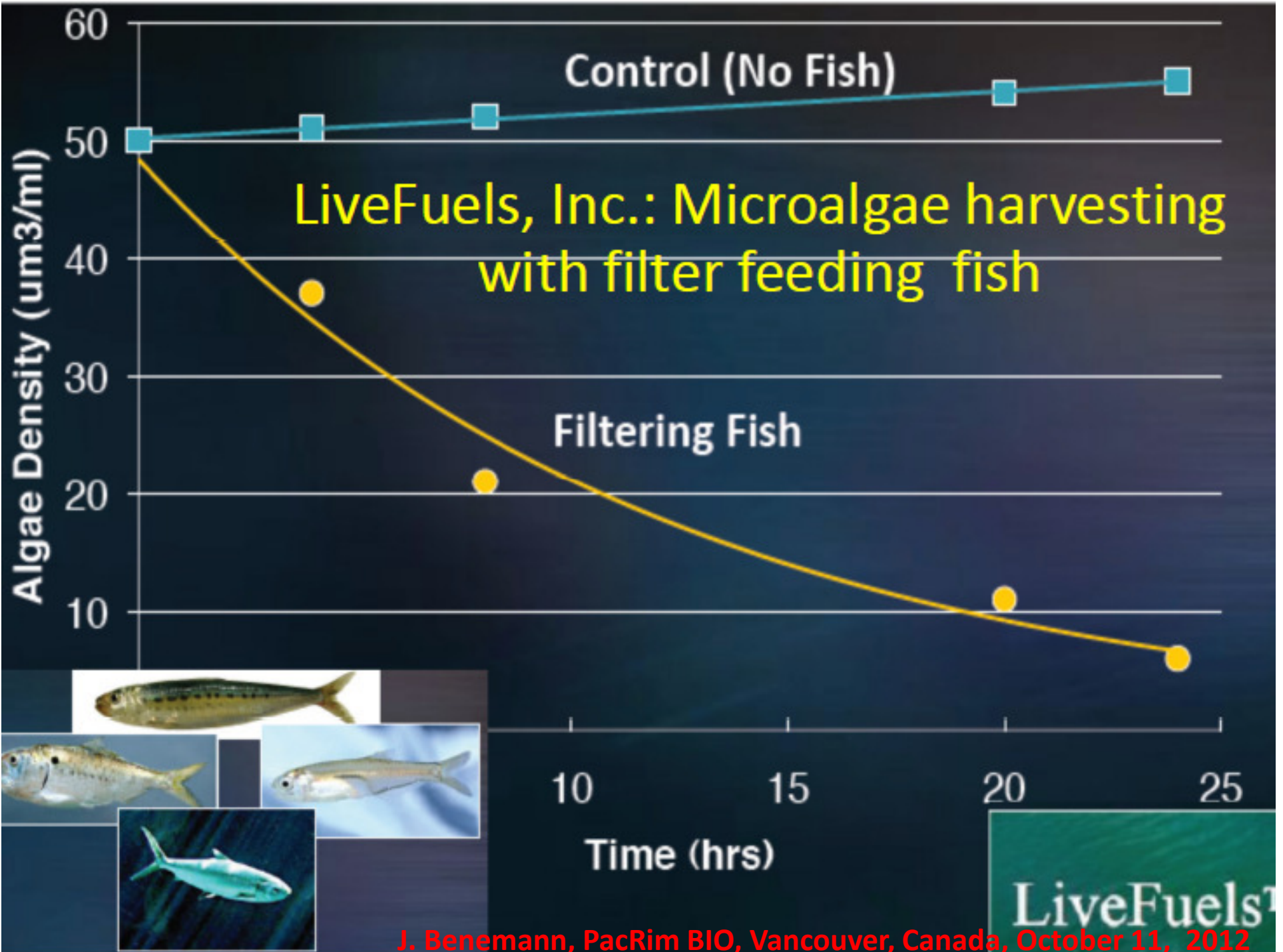
**Mr. Stan Barnes**, CEO, Bioalgae, WA, discusses integration of algal wastewater treatment with power plant CO2 capture.

**Ms. Shay Simpson**, Corporate Relations, TAMU, Texas AgriLife Research, presents ongoing R&D in algae production in arid (Pecos, TX) and coastal (Flour Bluff Station, TX) environments.

**Dr. Amit Vasavada**, General Atomics, CA, reviews research on microalgae biofuels production, both autotrophic (using sunlight & CO2) and heterotrophic (fermentation of sugars).

**Dr. Kirsten Heimann**, James Cook University, Queensland, reports on integrating microalgae animal feeds production with power plant flue CO2 utilization.

Apologies: two last minute cancellations, Lissa Morgenthaler-Jones, LiveFuels and Martin Sabarsky, Cellana, see next slides



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# Cellana (Hawaii) Combine PBRs with raceway ponds...



**Ponds**

**Photobioreactors**

# **HOW MUCH GLOBAL ALGAL BIOMASS R,D,D&D?** (Research, Development, Demonstration, Deployment)

**What does this include?: Commodities - Biofuels, chemicals, feeds, fertilizer, waste treatment, etc.  
exclude?: Higher value products (~\$10+/kg)  
also all current seaweed products.**

**How much investment? Govt. funding (applied, not basic)  
Venture capital, Angel investors, self  
Energy companies: oil, power, etc.  
Other Industries: Aviation, chemicals...**

**How many algae companies? Start-ups: small, medium, large**

**How many university projects, industry-academia consortia?**

**Support Industries? Suppliers, Equipment, Consultants, etc.**

**How many algae conferences, summits, etc.? Attendees?**

**HOW MANY JOBS IN THE ALGAL BIOMASS INDUSTRY?**

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# **“STATS” FOR GLOBAL ALGAL BIOMASS R,D,D&D**

**(Research, Development, Demonstration, Deployment)**

**For commodities, low cost products- biofuels, feeds, etc.**

**How much investment?: Global ~\$1 billion/year??**

**How many companies? Start-ups/small: hundreds  
medium to large: scores  
Corporate projects: dozens**

**How many university teams, projects?: Hundreds  
consortia?: Dozens**

**How many algae conferences?: Close to a hundred  
Attendees?: >100/avg = 10,000**

**Suppliers, Equipment, Consultants, etc.?: enough**

# **EMPLOYMENT IN ALGAL BIOMASS R,D,D&D?**

**(Research, Development, Demonstration, Deployment)**

**Commodities, low cost products- Biofuels, feeds, etc.**

**Excludes currently commercial macro-, micro-algae companies**

## **HOW MANY JOBS IN THE ALGAE BIOMASS INDUSTRY?**

**(my) best guess is approaching 10,000 employed\***  
**includes universities and private sector**  
**about equally divided (on an FTE basis)**

**\*Not including suppliers, consultants, support services  
(e.g. patent attorneys), construction, conferences, etc.**

# **Example: INDIA, Microalgae Biofuel R,D&D\***

**Major Programs funded by the Indian Government and Companies:**

- 1. Indian Govt. Department of Biotechnology, ~\$2 million**
- 2. Council of Scientific and Industrial Research, ~\$4 million**
- 3. Indian Council of Agricultural Res. 2 nodal projects, ~\$5 million**
- 4. International Collaborations (US, UK, Australia, variable grants).**
- 5. Reliance Electric Company (unknown funding, larger than govt.?)**
- 6. Individual Institutes/Universities (U. Madras; CFTRI in Mysore; Ganhati University, Thapar Inst., Visva –Bharati, Santiniketan; and many private engineering institutes), \$1 -2 million**

**Summary:** over \$10 million invested, in R&D. Not clear over what period.  
Also projects on fertilizers, etc. **Employment est. at >500.**

**\*thanks to Prof. S.P. Adhikary, Visva-Bharati Central Univ. , West Bengal**  
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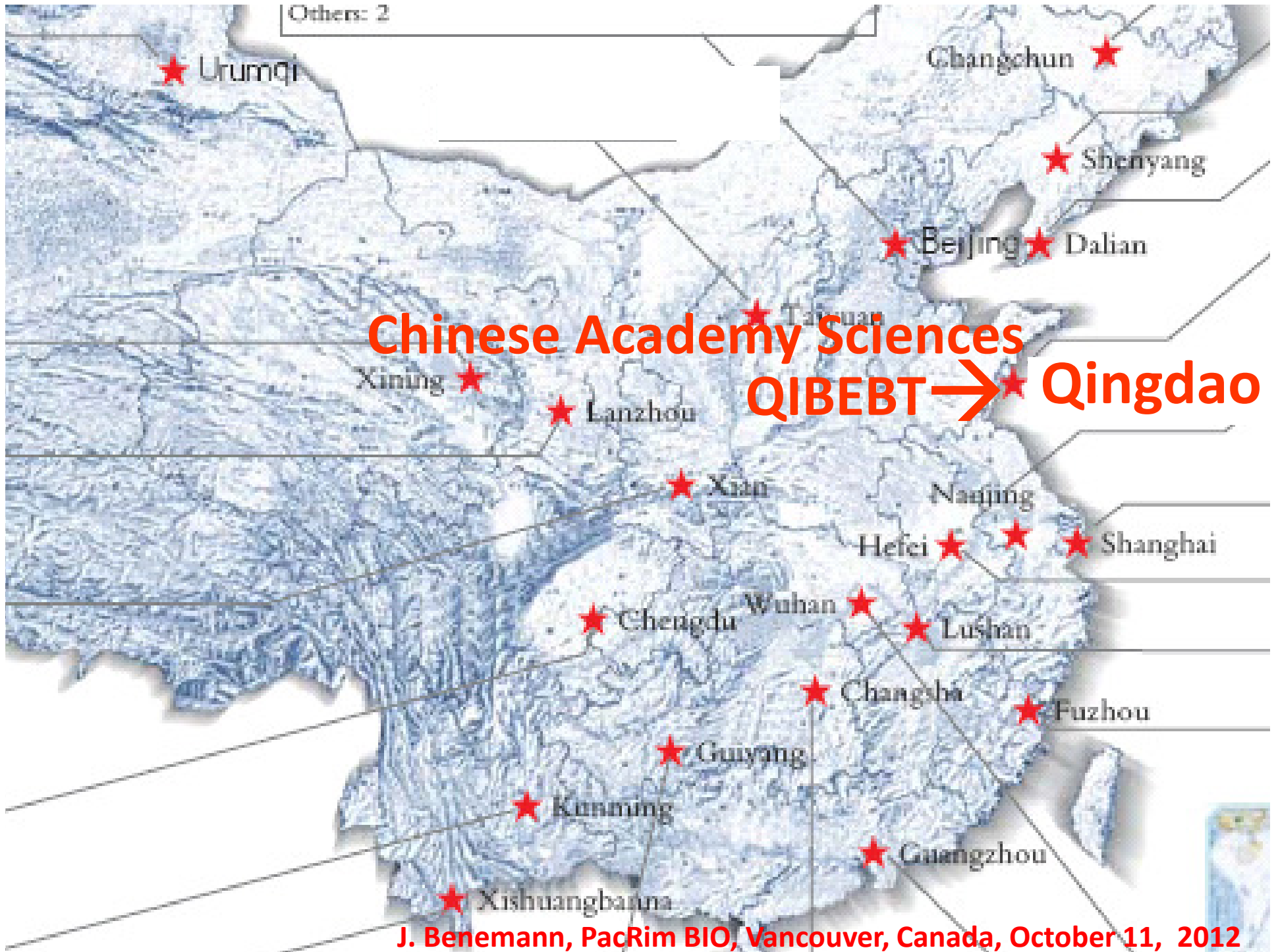


## Major algal biofuels consortia funded by Chinese government

Funding period	Agency	Consortia name	Leading organization
2013-14	MoST-863	<i>"Synthetic biology of photosynthetic cell factory for production of advanced biofuels"</i>	CAS-QIBEBT (7 institutions)
2011-15	MoST 973	<i>"Production of energy using photosynthetic microalgae"</i>	ECUST (12 institutions)
2009-2012	MoST 863	<i>"Coupling oil production with CO2 sequestration using microalgae"</i>	ENN (8 institutions)
2011-15	MoST R&D Support	<i>"Environmental protection and energy production using microalgae"</i>	Tsinghua University (15 institutions)
2010-12	CAS	<i>"Solar energy action plan – the biological route"</i>	CAS-QIBEBT (5 institutions)
2011-13	NSFC	<i>"Establishing a research model for systems biology in microalgal oil production"</i>	CAS-QIBEBT (2 institutions)

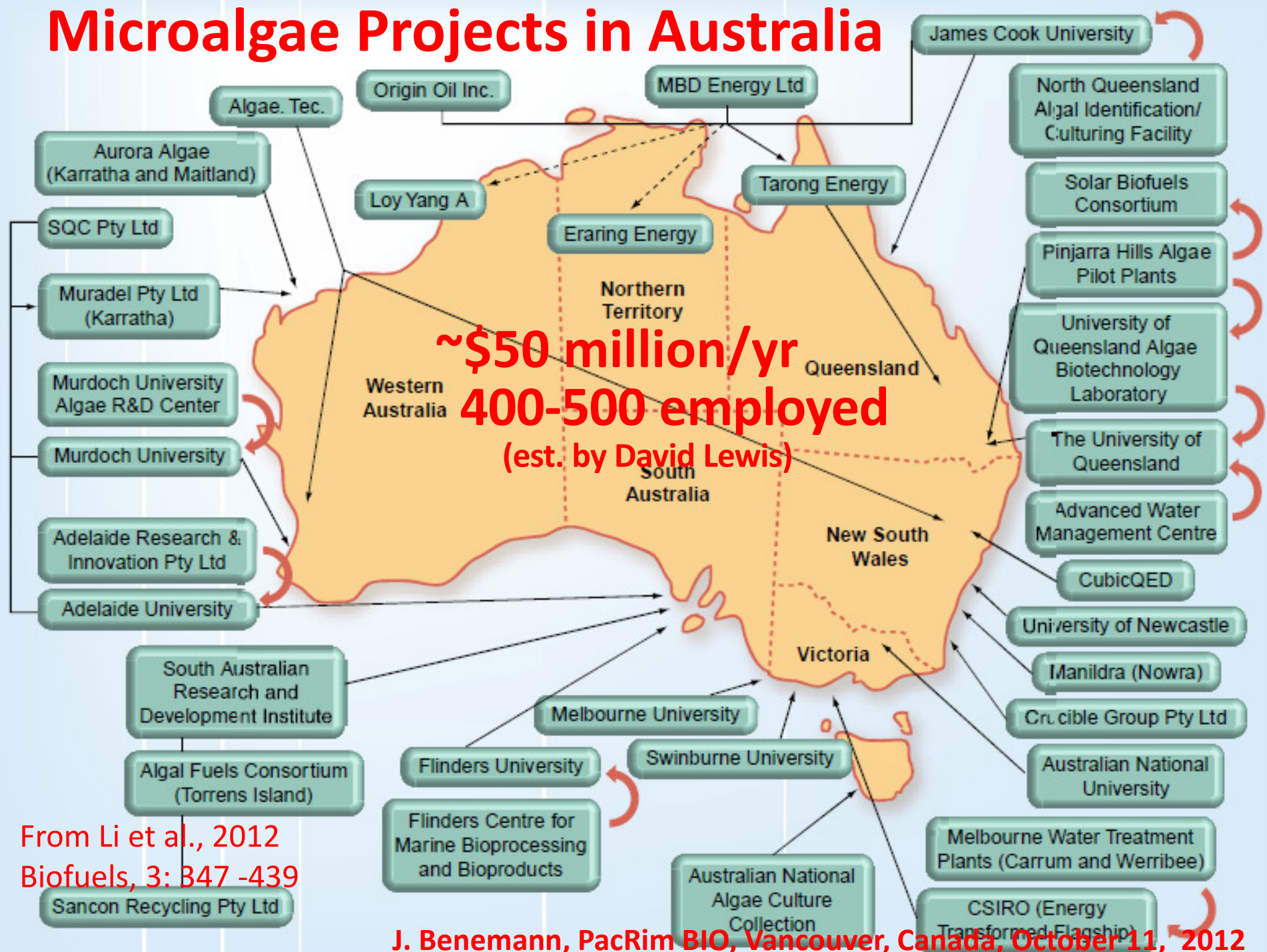
\*Prof. Jian Xu, Director, BioEnergy Genome Center, Qingdao Inst. BioEnergy and Bioprocess Technology

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# Microalgae Projects in Australia



From Li et al., 2012  
Biofuels, 3: 347-439

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# Biomass Research Projects in Korea

NAME OF PROJECT	ORGANIZATION	FUNDING	YEARS
ABC Advanced Biomass R&D Center (Global Frontier Project),	KAIST	\$150 M	2010 -2019
Novel Bioconversion Platform Technology based on Marine Micro-organisms,	Hanyang U.	\$2.3 M	2010-2014
Marine Bioenergy Research Consortium	Inha U.	\$44.5 M	2009-2019
Microalgae Biodiesel Production Using PBR/Pond Hybrid System	NLP Co.	\$13.7 M	2012-2017
CO2 Fixation and Astaxanthin production by Microalgae,	Korea U.	\$11.2 M	2012-2017
Development of Biofuels Production, Technologies using Algae	KIER	\$6.8 M	2009 -2013

From Choul-Gyun LEE, Inha U. Presentation Algal Biomass Summit September, 2012

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# **EMPLOYMENT IN ALGAL BIOMASS R,D,D&D?**

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## **ALGAL BIOMASS R,D,D&D INDUSTRY JOBS? My Guess\***

**USA 3,000**

**Europe 2,000**

**China 500**

**India 500**

**Other Asia 500**

**Australia, NZ 500**

**Middle East , Africa 500**

**Latin America 500**

**Other? 500**

**\*Adds up to 8,500**

# **WHAT'S NEW IN ALGAL BIOMASS R,D,D&D?**

**(Research, Development, Demonstration, Deployment)**

**Almost every OECD country has some algae projects**

**Seem to be no geographic limitations (Iceland too!)**

**Global boom in algae projects continues unabated**

**Hype, hubris, hoopla, hope, also continue unabated**

**Many new players entering field, a few are exiting**

**Large companies in many countries now joining fray**

**Not settled on technology (ponds, PBRs, fermenters)**

**Fuels ceding some ground to animal feeds, not much**

**Wastewater treatment invoked for nutrients, water, \$**

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# **WHEN WILL ALGAL BIOMASS R,D,D&D BE **D**?**

**(Research, Development, Demonstration, **Deployment**)**

**Not yet commercial scale (autotrophic, heterotrophic)  
(OK, but only 20,000 gallons of cellulosic ethanol produced so far)**

**Sapphire demonstration plant launched this year**

**Other projects at pilot, some close to demo scale**

**Pilot, demo, production projects announced daily**

**Past performance is no assurance of future failure**

**Experience suggests that it may take a bit longer**

**Fast growth of algae → rapid R,D,D,**&D** when/if**



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