EBC

Energy in Buildings and Communities Programme

ANNEX 69

Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings

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Tsinghua University
China

Richard de Dear
The University of Sydney
Australia

Singapore, 2017

Annex 69 Organization

- **Operating Agents:**
  - Yingxin Zhu, Tsinghua University, China
  - Richard de Dear, The University of Sydney, Australia
- **Secretary:**
  - Bin Cao, Tsinghua University, China
- **Subtask Leaders:**
  - ST-A: Edward Arens, UC Berkeley, USA
  - ST-B: Bjarne Olesen, DTU, Denmark
  - ST-C: Richard de Dear, The University of Sydney, Australia

Expected outcomes

	Outcomes	Target Audience
1	Database with user interface including information of human thermal reaction together with their behavior and energy consumption	Researchers, government agencies
2	Develop a model and criteria for the application of adaptive thermal comfort in built environment	Researchers, code and standard developers, policy makers, designers
3	Guidelines for low energy building design based on adaptive thermal comfort concept	Building designers
4	Guidelines for personal thermal comfort systems in low energy buildings	HVAC engineers, facility managers, HVAC equipment manufacturers

Objectives

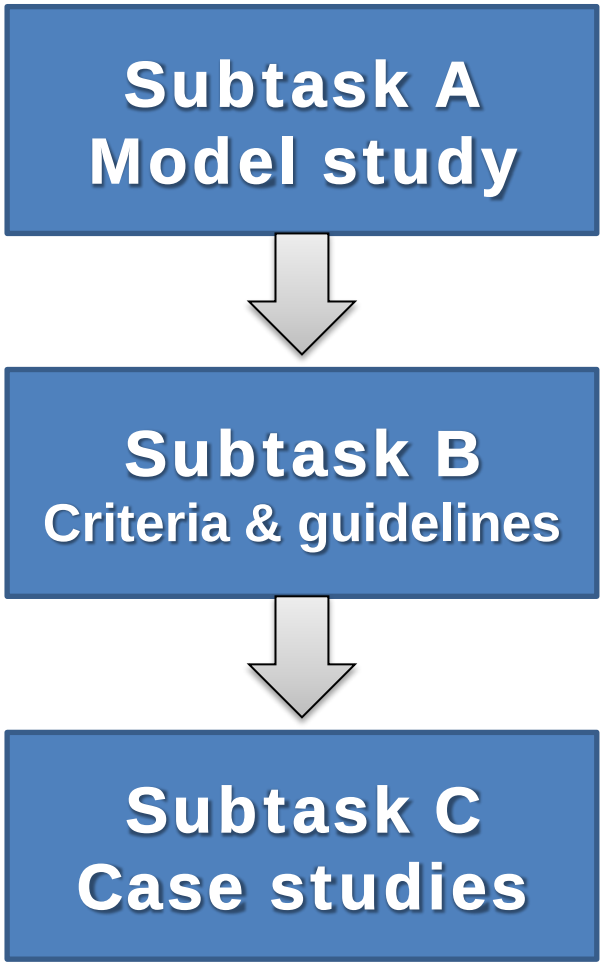
- New database with more climate & building types
- Adaptive thermal comfort model with mechanism

- Revised criteria for current standards
- New criteria for mixed-mode buildings

- Guideline for low energy building design
- Guideline for personal thermal comfort system

Case Study

Technical Approach



- Data collection and research into models of adaptation
- Criteria and guidelines for adaptive comfort and Personal Thermal Comfort Systems in standards
- Practical learnings from exemplary adaptive buildings, supporting Subtasks A & B

Subtask A: Data collection & model

Leader: Prof. Edward Arens, UC Berkeley, USA

Sub A1: Standardize the description of field study data from various resources and make a uniform data format.

Sub A2: Collect existing field data and establish a worldwide database.

Sub A3: Quantification of uncertainty in thermal comfort instruments (objective and subjective)

Sub A4: Integrating the mechanisms of thermal adaptation and the database to develop the revised gray box adaptive thermal comfort model.

Subtask B: Criteria and guidelines for adaptive comfort and Personal Thermal Comfort Systems in standards

Leader: Prof. Bjarne Olesen, DTU, Denmark

Sub B1: Analyze and improve the adaptive model and criteria for use in existing standards criteria for indoor thermal environment.

Sub B2: Provide design guidelines on how to use adaptive comfort for lowering energy in buildings.

Sub B3: Provide design criteria and guidelines for Personal Thermal Comfort Systems.

Sub B4: Development of an open access code repository for thermal comfort indices.

Subtask C: Case studies - Practical learnings from exemplary adaptive buildings, supporting Subtasks A & B

Leader: Prof. Richard de Dear, The University of Sydney, Australia
Founder of ASHRAE's adaptive thermal comfort model/standard

Sub C1: Conduct instrumental indoor environment measurements to analyze the performance of target buildings from the view of indoor comfort, occupant behavior, and energy use.

Sub C2: Lessons learned and develop recommendations for "adaptive" building design, operation and refurbishment.

Sub C3: Collect successful cases to compile a compendium, as an appendix of the guidelines from Subtask B, to help readers to relate the outcomes of this project to their work.

Participants and their intentions in each subtask

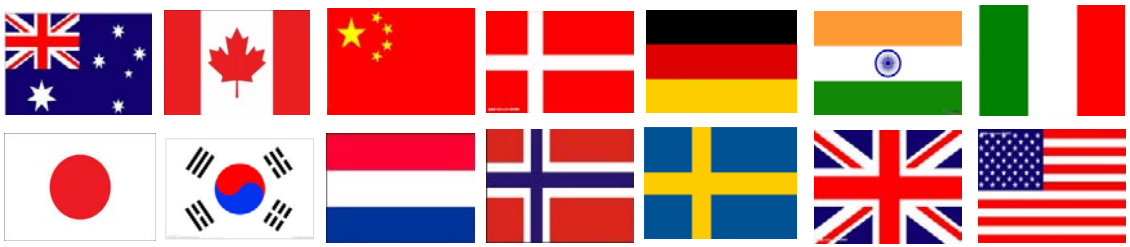
36 Institute from **14** countries

	Country	Researcher	Institute	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3
1	Australia	Richard de Dear	The University of Sydney		■		■					■	■	■
2		Jungsoo Kim										■		
3	Australia	Paul Cooper	University of Wollongong		■							■		
4	Canada	Rodrigo Mora	British Columbia Institute of Technology					■	■			■	■	■
5	China	Yingxin Zhu	Tsinghua University	■	■		■	■		■		■	■	■
6		Bin Cao		■	■		■	■		■		■	■	■
7	China	Liu Yang	Xi'an University of Architecture and Technology		■	■			■			■		
8		Yongchao Zhai				■								
9	China	Zhaojun Wang	Harbin Institute of Technology		■	■		■	■			■		
10	China	Yufeng Zhang	South China University of Technology		■	■		■	■					
11	China	Hang Yu	Tongji University			■				■		■		
12		Xiang Zhou				■			■			■		
13	China	Lin Duanmu	Dalian University of Technology							■				
14	China	Zhiwei Lian	Shanghai Jiaotong Univ.				■							

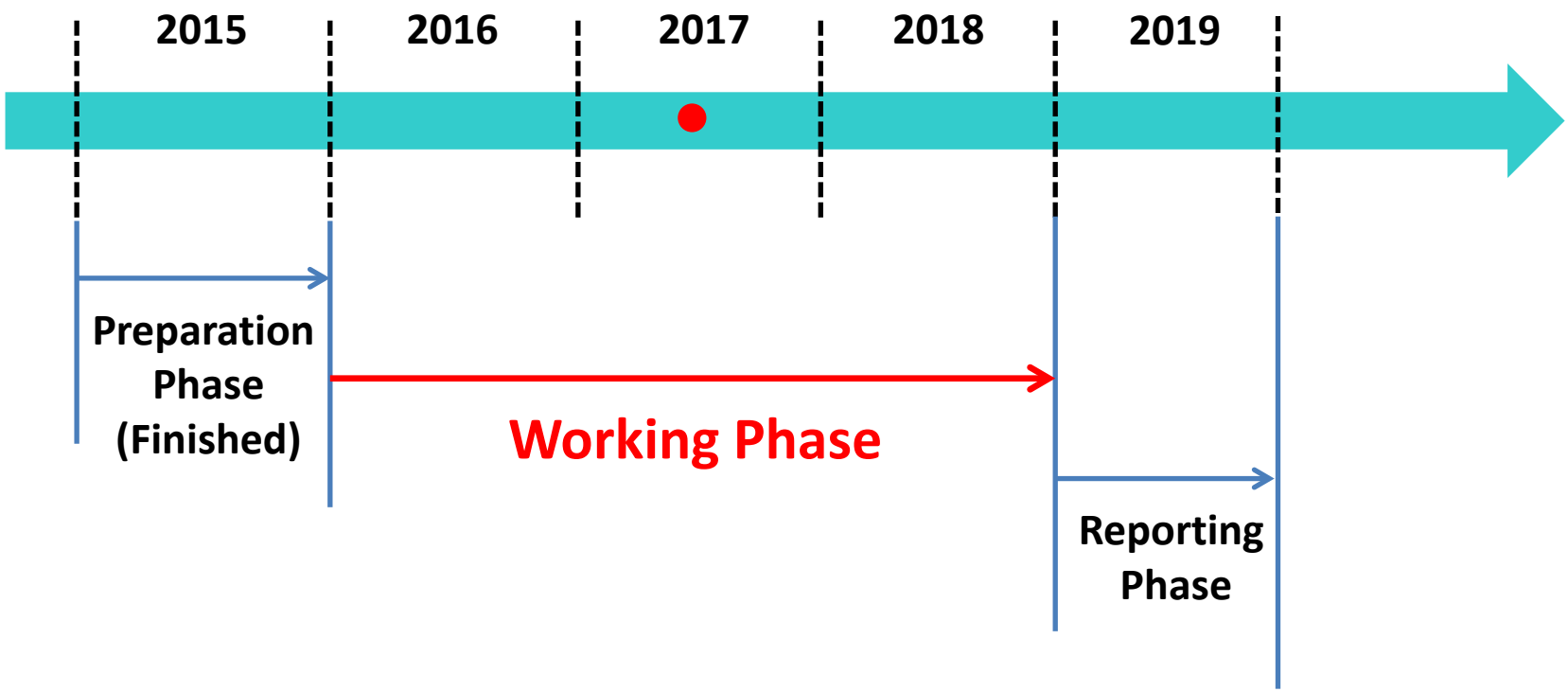
	Country	Researcher	Institute	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3
15	Denmark	Bjarne Olesen	Technical University of Denmark											
16		Jorn Toftum												
17		Ongun Berk Kazanci												
18	Denmark	Henrik N. Kundsen	Aalborg University											
19	Germany	Runa Hellwig	Augsburg University of Applied Science											
20	Germany	Marcel Schweiker	Karlsruhe Institute of Technology											
21		Andreas Wagner												
22	Germany	Christoph van Treeck	RWTH Aachen University											
23	India	Rajan Rawal	CEPT University											
24	Italy	Rossano Albatici	University of Trento											
25	Japan	Hiroshi Yoshino	Tohoku University											
26	Japan	Tomonobu Goto												
27	Japan	Shinichi Tanabe	Waseda University											
28	Japan	Ryozo Ooka	The University of Tokyo											
29	Japan	Hom Rijal	Tokyo City University											

	Country	Researcher	Institute	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3
30	Japan	Kazuyo Tsuzuki	National Institute of Advanced Industrial Science and Technology											
31	Korea	Chungyoon Chun	Yonsei University											
32	The Nether-lands	Wouter van Marken Lichtenbelt	Maastricht University											
33		Lisje Schellen												
34	Norway	Salvatore Carlucci	Norwegian University of Science and Technology											
35	Sweden	Thomas Olofsson	Umea University											
36		Bin Yang												
37	Sweden	Despoina Teli	Chalmers University of Technology											
38		Quan Jin												
39	UK	Michael Humphreys	Oxford Brookes University											
40	UK	Fergus Nicol	London Metropolitan University											
41	UK	David Shipworth	University College London											

	Country	Researcher	Institute	A1	A2	A3	A4	B1	B2	B3	B4	C1	C2	C3
42	UK	Stephanie Gauthier	University of Southampton											
43	UK	Dennis Loveday	Loughborough University											
44	UK	Mahroo Eftekhari	Loughborough University											
45	UK	Shen Wei	Northumbria University											
46	USA	Edward Arens	UC Berkeley											
47	USA	Hui Zhang	UC Berkeley											
48	USA	Gail Brager	UC Berkeley											
49	USA	Stefano Schiavon	UC Berkeley											
50	USA	Hyojin Kim	The Catholic University of America											
51	USA	Joon-Ho Choi	University of Southern California											



Timeline



The working phase was proposed to extend for 1 year.

Participants at the Open Forum for Annex 69 in Hong Kong, China, July 11th, 2014

Participants at the Open Forum for Annex 69 in May 20th, 2015 in Eindhoven, Netherland

Every half-year experts meetings within our Annex

- May, 2015. 1st experts meeting in Eindhoven, the Netherlands.

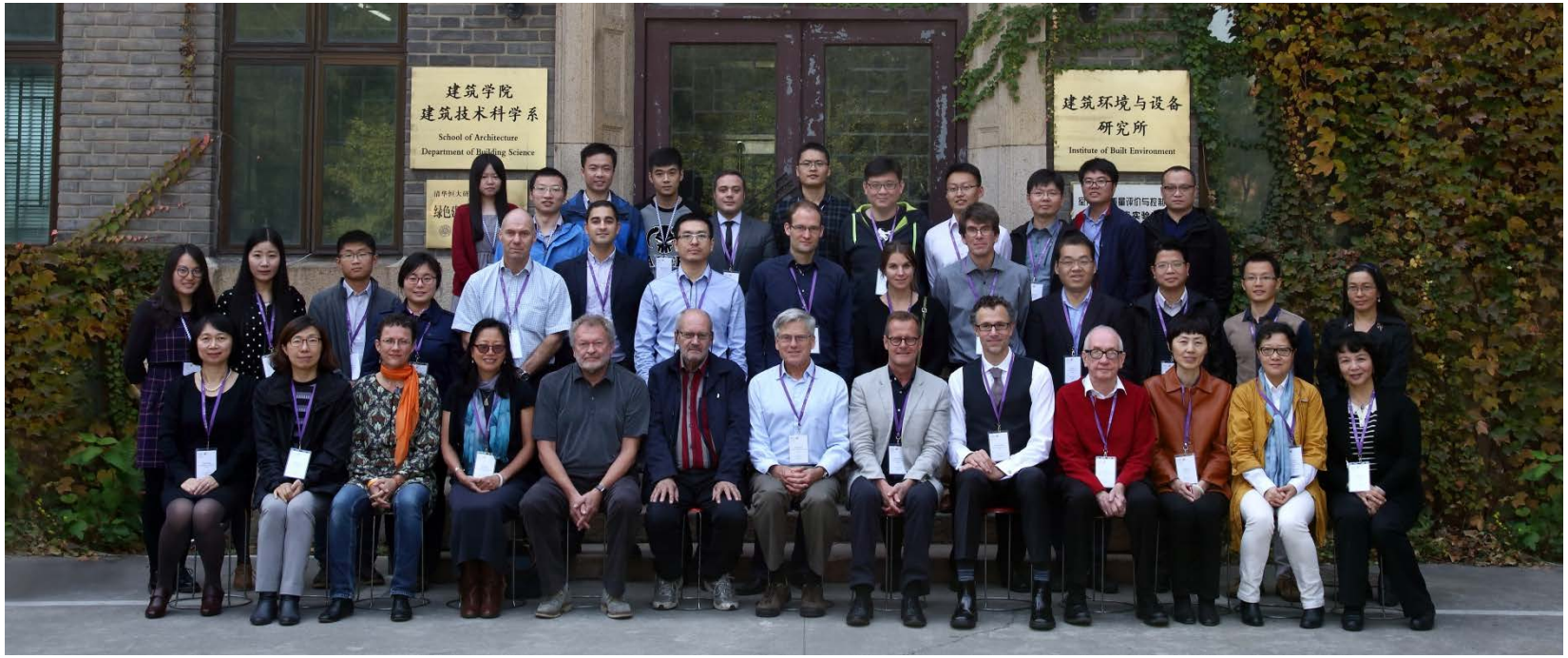
- 14 participants from 8 countries (China, Denmark, Germany, Japan, Netherlands, Singapore, Sweden, UK)

Our participation in the IEA-EBC ExCo meetings

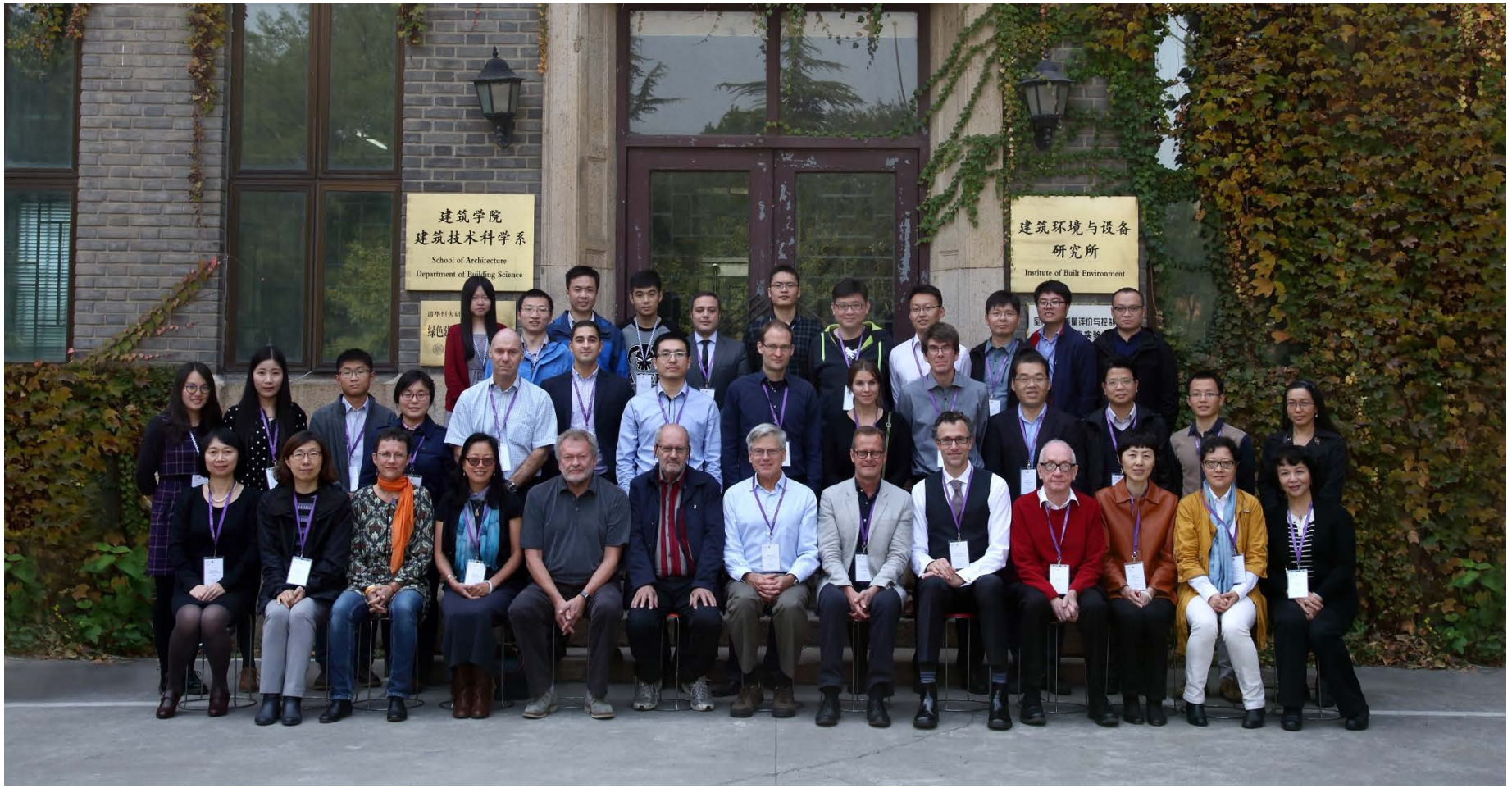
- June, 2014. 75th meeting in Germany
  - Yingxin introduced the concept proposal.
- November, 2014. 76th meeting in Finland
  - Yingxin introduced the full proposal and was approved.
- June, 2015. 77th meeting in Portugal
  - Richard & Bin reported the first half-year progress.
- November, 2015. 78th meeting in Korea
  - Yingxin reported progress of the whole preparation phase and was approved to start working phase.
- June, 2016. 79th meeting in Norway
  - Yingxin reported the latest progress in working phase.
- November, 2016. 80th meeting in Australia
  - Bin went and reported the latest progress in working phase.

Progress in the preparation year

- **2nd preparation phase meeting at Beijing (China), October 19-20, 2015**
- **38 participants from 10 countries (Australia, China, Denmark, Germany, Korea, Norway, Singapore, Sweden, UK, USA)**



October, 2015. 2nd experts meeting in Beijing, China.



- **38 participants from 10 countries** (Australia, China, Denmark, Germany, Korea, Norway, Singapore, Sweden, UK, USA)

April, 2016. 3rd experts meeting in London, UK.

- 39 participants from 13 countries

October, 2016. 4th experts meeting in Seoul, Korea.

Factsheet

Participating Countries

Australia, Canada, China, Denmark, Germany, Italy, Japan, Korea, the Netherlands, Norway, Sweden, UK, USA

Related Events

Experts Meetings:

Eindhoven, the Netherlands, May 20th, 2015
Beijing, China, October 19th-20th, 2015
London, UK, April 6th -7th, 2016th-28th, 2016

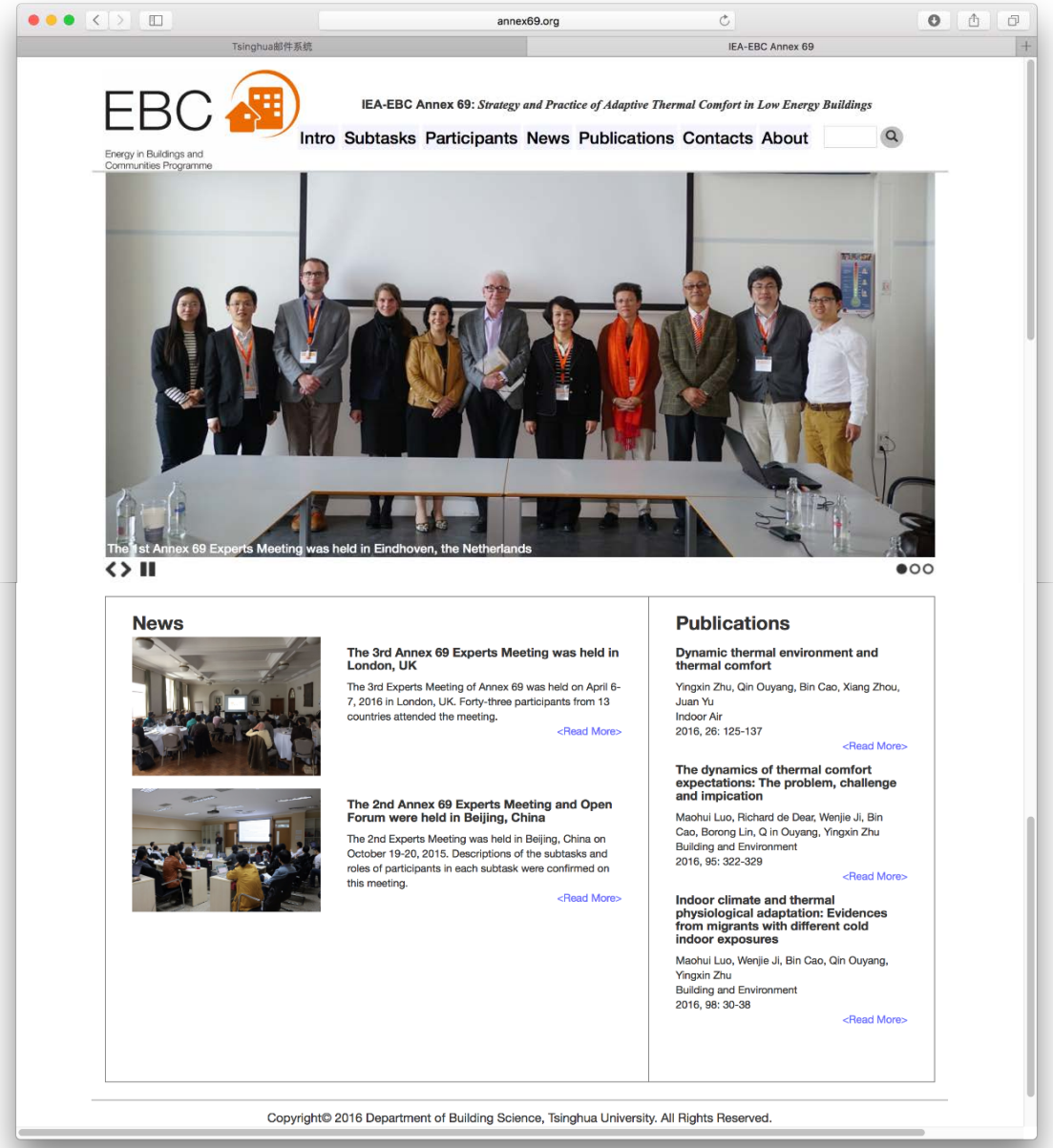
Workshops / Open Forums:

Hong Kong, China, July 11th, 2014
Tianjin, China, July 13th, 2015
Beijing, China, October 20th, 2015
Windsor, UK, April 8th, 2016
Incheon, Korea, October 24th-25th, 2016
Nagoya, Japan, October, 2016

More information

http://www.annex69.org
http://www.iea-ebc.org/projects/ongoing-projects/ebc-annex-69

Website www.annex69.org



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Thanks for your attention!