

International Energy Agency

EBC Working Group Final Report: Cities and Communities

Energy in Buildings and Communities Technology Collaboration Programme

December 2020





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Editors

SIR - Salzburg Institute for Regional Planning and Housing Nina Mostegl nina.mostegl@salzburg.gv.at Helmut Strasser helmut.strasser@salzburg.gv.at EIFER - European Institute for Energy Research Andreas Koch andreas.koch@eifer.org Marie Sevenet marie.sevenet@eifer.org RVO - Netherlands Enterprise Agency Jacques Kimman jacques.kimman@rvo.nl

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Participating countries in the EBC TCP: Australia, Austria, Belgium, Brazil, Canada, P.R. China, Czech Republic, Denmark, Finland, France, Germany, Ireland, Italy, Japan, Republic of Korea, the Netherlands, New Zealand, Norway, Portugal, Singapore, Spain, Sweden, Switzerland, Turkey, United Kingdom and the United States of America.

Additional copies of this report may be obtained from: EBC Executive Committee Support Services Unit (ESSU), C/o AECOM Ltd, The Colmore Building, Colmore Circus Queensway, Birmingham B4 6AT, United Kingdom www.iea-ebc.org essu@iea-ebc.org

Preface

The International Energy Agency

The International Energy Agency (IEA) was established in 1974 within the framework of the Organisation for Economic Co-operation and Development (OECD) to implement an international energy programme. A basic aim of the IEA is to foster international co-operation among the 30 IEA participating countries and to increase energy security through energy research, development and demonstration in the fields of technologies for energy efficiency and renewable energy sources.

The IEA Energy in Buildings and Communities Programme

The IEA co-ordinates international energy research and development (R&D) activities through a comprehensive portfolio of Technology Collaboration Programmes (TCPs). The mission of the IEA Energy in Buildings and Communities (IEA EBC) TCP is to support the acceleration of the transformation of the built environment towards more energy efficient and sustainable buildings and communities, by the development and dissemination of knowledge, technologies and processes and other solutions through international collaborative research and open innovation. (Until 2013, the IEA EBC Programme was known as the IEA Energy Conservation in Buildings and Community Systems Programme, ECBCS.)

The high priority research themes in the EBC Strategic Plan 2019-2024 are based on research drivers, national programmes within the EBC participating countries, the Future Buildings Forum (FBF) Think Tank Workshop held in Singapore in October 2017 and a Strategy Planning Workshop held at the EBC Executive Committee Meeting in November 2017. The research themes represent a collective input of the Executive Committee members and Operating Agents to exploit technological and other opportunities to save energy in the buildings sector, and to remove technical obstacles to market penetration of new energy technologies, systems and processes. Future EBC collaborative research and innovation work should have its focus on these themes.

At the Strategy Planning Workshop in 2017, some 40 research themes were developed. From those 40 themes, 10 themes of special high priority have been extracted, taking into consideration a score that was given to each theme at the workshop. The 10 high priority themes can be separated in two types namely 'Objectives' and 'Means'. These two groups are distinguished for a better understanding of the different themes.

Objectives - The strategic objectives of the EBC TCP are as follows:

- reinforcing the technical and economic basis for refurbishment of existing buildings, including financing, engagement of stakeholders and promotion of co-benefits;
- improvement of planning, construction and management processes to reduce the performance gap between design stage assessments and real-world operation;
- the creation of 'low tech', robust and affordable technologies;
- the further development of energy efficient cooling in hot and humid, or dry climates, avoiding mechanical cooling if possible;
- the creation of holistic solution sets for district level systems taking into account energy grids, overall
 performance, business models, engagement of stakeholders, and transport energy system implications.

Means - The strategic objectives of the EBC TCP will be achieved by the means listed below:

- the creation of tools for supporting design and construction through to operations and maintenance, including building energy standards and life cycle analysis (LCA);
- benefitting from 'living labs' to provide experience of and overcome barriers to adoption of energy efficiency measures;
- improving smart control of building services technical installations, including occupant and operator interfaces;

- addressing data issues in buildings, including non-intrusive and secure data collection;
- the development of building information modelling (BIM) as a game changer, from design and construction through to operations and maintenance.

The themes in both groups can be the subject for new Annexes, but what distinguishes them is that the 'objectives' themes are final goals or solutions (or part of) for an energy efficient built environment, while the 'means' themes are instruments or enablers to reach such a goal. These themes are explained in more detail in the EBC Strategic Plan 2019-2024.

The Executive Committee

Overall control of the IEA EBC Programme is maintained by an Executive Committee, which not only monitors existing projects, but also identifies new strategic areas in which collaborative efforts may be beneficial. As the Programme is based on a contract with the IEA, the projects are legally established as Annexes to the IEA EBC Implementing Agreement. At the present time, the following projects have been initiated by the IEA EBC Executive Committee, with completed projects identified by (*) and joint projects with the IEA Solar Heating and Cooling Technology Collaboration Programme by (x):

- Annex 1: Load Energy Determination of Buildings (*)
- Annex 2: Ekistics and Advanced Community Energy Systems (*)
- Annex 3: Energy Conservation in Residential Buildings (*)
- Annex 4: Glasgow Commercial Building Monitoring (*)
- Annex 5: Air Infiltration and Ventilation Centre
- Annex 6: Energy Systems and Design of Communities (*)
- Annex 7: Local Government Energy Planning (*)
- Annex 8: Inhabitants Behaviour with Regard to Ventilation (*)
- Annex 9: Minimum Ventilation Rates (*)
- Annex 10: Building HVAC System Simulation (*)
- Annex 11: Energy Auditing (*)
- Annex 12: Windows and Fenestration (*)
- Annex 13: Energy Management in Hospitals (*)
- Annex 14: Condensation and Energy (*)
- Annex 15: Energy Efficiency in Schools (*)
- Annex 16: BEMS 1- User Interfaces and System Integration (*)
- Annex 17: BEMS 2- Evaluation and Emulation Techniques (*)
- Annex 18: Demand Controlled Ventilation Systems (*)
- Annex 19: Low Slope Roof Systems (*)
- Annex 20: Air Flow Patterns within Buildings (*)
- Annex 21: Thermal Modelling (*)
- Annex 22: Energy Efficient Communities (*)
- Annex 23: Multi Zone Air Flow Modelling (COMIS) (*)
- Annex 24: Heat, Air and Moisture Transfer in Envelopes (*)
- Annex 25: Real time HVAC Simulation (*)
- Annex 26: Energy Efficient Ventilation of Large Enclosures (*)
- Annex 27: Evaluation and Demonstration of Domestic Ventilation Systems (*)
- Annex 28: Low Energy Cooling Systems (*)
- Annex 29: \Leftrightarrow Daylight in Buildings (*)
- Annex 30: Bringing Simulation to Application (*)
- Annex 31: Energy-Related Environmental Impact of Buildings (*)
- Annex 32: Integral Building Envelope Performance Assessment (*)
- Annex 33: Advanced Local Energy Planning (*)
- Annex 34: Computer-Aided Evaluation of HVAC System Performance (*)
- Annex 35: Design of Energy Efficient Hybrid Ventilation (HYBVENT) (*)
- Annex 36: Retrofitting of Educational Buildings (*)
- Annex 37: Low Exergy Systems for Heating and Cooling of Buildings (LowEx) (*)
- Annex 38: \bigotimes Solar Sustainable Housing (*)
- Annex 39: High Performance Insulation Systems (*)

- Annex 40: Building Commissioning to Improve Energy Performance (*)
- Annex 41: Whole Building Heat, Air and Moisture Response (MOIST-ENG) (*)
- Annex 42: The Simulation of Building-Integrated Fuel Cell and Other Cogeneration Systems (FC+COGEN-SIM) (*)
- Annex 43: 🌣 Testing and Validation of Building Energy Simulation Tools (*)
- Annex 44: Integrating Environmentally Responsive Elements in Buildings (*)
- Annex 45: Energy Efficient Electric Lighting for Buildings (*)
- Annex 46: Holistic Assessment Tool-kit on Energy Efficient Retrofit Measures for Government Buildings (EnERGo) (*)
- Annex 47: Cost-Effective Commissioning for Existing and Low Energy Buildings (*)
- Annex 48: Heat Pumping and Reversible Air Conditioning (*)
- Annex 49: Low Exergy Systems for High Performance Buildings and Communities (*)
- Annex 50: Prefabricated Systems for Low Energy Renovation of Residential Buildings (*)
- Annex 51: Energy Efficient Communities (*)
- Annex 52: 🌣 Towards Net Zero Energy Solar Buildings (*)
- Annex 53: Total Energy Use in Buildings: Analysis and Evaluation Methods (*)
- Annex 54: Integration of Micro-Generation and Related Energy Technologies in Buildings (*)
- Annex 55: Reliability of Energy Efficient Building Retrofitting Probability Assessment of Performance and Cost (RAP-RETRO) (*)
- Annex 56: Cost Effective Energy and CO2 Emissions Optimization in Building Renovation (*)
- Annex 57: Evaluation of Embodied Energy and CO2 Equivalent Emissions for Building Construction (*)
- Annex 58: Reliable Building Energy Performance Characterisation Based on Full Scale Dynamic Measurements (*)
- Annex 59: High Temperature Cooling and Low Temperature Heating in Buildings (*)
- Annex 60: New Generation Computational Tools for Building and Community Energy Systems (*)
- Annex 61: Business and Technical Concepts for Deep Energy Retrofit of Public Buildings (*)
- Annex 62: Ventilative Cooling (*)
- Annex 63: Implementation of Energy Strategies in Communities (*)
- Annex 64: LowEx Communities Optimised Performance of Energy Supply Systems with Exergy Principles (*)
- Annex 65: Long-Term Performance of Super-Insulating Materials in Building Components and Systems (*)
- Annex 66: Definition and Simulation of Occupant Behavior in Buildings (*)
- Annex 67: Energy Flexible Buildings (*)
- Annex 68: Indoor Air Quality Design and Control in Low Energy Residential Buildings (*)
- Annex 69: Strategy and Practice of Adaptive Thermal Comfort in Low Energy Buildings
- Annex 70: Energy Epidemiology: Analysis of Real Building Energy Use at Scale
- Annex 71: Building Energy Performance Assessment Based on In-situ Measurements
- Annex 72: Assessing Life Cycle Related Environmental Impacts Caused by Buildings
- Annex 73: Towards Net Zero Energy Resilient Public Communities
- Annex 74: Competition and Living Lab Platform
- Annex 75: Cost-effective Building Renovation at District Level Combining Energy Efficiency and Renewables
- Annex 76: CO₂ Emissions
 CO₂ Emissions
- Annex 77: 🌣 Integrated Solutions for Daylight and Electric Lighting
- Annex 78: Supplementing Ventilation with Gas-phase Air Cleaning, Implementation and Energy Implications
- Annex 79: Occupant-Centric Building Design and Operation
- Annex 80: Resilient Cooling
- Annex 81: Data-Driven Smart Buildings
- Annex 82: Energy Flexible Buildings Towards Resilient Low Carbon Energy Systems
- Annex 83: Positive Energy Districts
- Annex 84: Demand Management of Buildings in Thermal Networks
- Annex 85: Indirect Evaporative Cooling
- Annex 86: Energy Efficient Indoor Air Quality Management in Residential Buildings

Working Group - Energy Efficiency in Educational Buildings (*)

Working Group - Indicators of Energy Efficiency in Cold Climate Buildings (*)

Working Group - Annex 36 Extension: The Energy Concept Adviser (*)

Working Group - HVAC Energy Calculation Methodologies for Non-residential Buildings (*) Working Group - Cities and Communities Working Group - Building Energy Codes

LIST OF PARTICIPANTS

REGULAR PARTICIPANTS

AT	Nina Mostegl	SIR-Salzburg Institute for Regional Planning and Housing
AT	Ralf-Roman Schmidt	Austrian Institute for Technology
AT	Helmut Strasser	SIR-Salzburg Institute for Regional Planning and Housing
CAN	Sarah Marchionda	(QUEST)
СН	Maren Kornmann	Enco AG
FRA	Andreas Koch	EIFER
FRA	Marie Sevenet	EIFER
FIN	Juha Kostiainen	VTT
FIN	Francesco Reda	VTT
FIN	Pekka Tuominen	VTT
GER	Judith Commenges	B.&S.U. Beratungs- und Servicegesellschaft Umwelt mbH
GER	Jens Freudenberg	Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung
GER	Uta Lynar	B.&S.U. Beratungs- und Servicegesellschaft Umwelt mbH
GER	Hauke Meyer	Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung
GER	Marie Preuss	Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung
JPN	Yoshiyuki Shimoda	Osaka University
NL	Jacques Kimman	Netherlands Enterprise Agency
NOR	Niki Gaitani	NTNU
NOR	Siri Joli	NTNU
NOR	Brita Fladvad Nielsen	NTNU
SWE	Emina Pasic	Swedish Energy Agency
UK	David Beeton	urbanforesight
UK	Paul Blakeman	urbanforesight
UK	Kate Palmer	urbanforesight
UK	Simon Tricker	urbanforesight
USA	Carissa Slotterback	University of Minnesota
DHC / GER	Andrej Jentsch	DHC Operating Agent
DHC / UK	Robin Wiltshire	BRE Building Research Establishment
SHC/A	Werner Weiß	AEE INTEC
SHC/I	Alessandra Scognamiglio	ENEA
SHC / SWE	Maria Wall	Lund University

ADDITIONAL PARTICIPANTS IN WORKING GROUP WORKSHOPS, PRESENTATIONS AND DISCUSSION

AT	Dina Bacovsky	BIOENERGY 2020+ GmbH
GER	Jan Dohnke	City of Berlin
GER	Anna Kallert	Fraunhofer IEE
GER	Alexandra Kapp	City of Berlin
GER	Magdalena Konieczezek-Woger	City of Berlin
GER	Wolfgang Kramer	Fraunhofer ISE

GER	Nadine Kuhla	City of Berlin
GER	Florian Noll	IZES Gmbh
GER	Annika Pieper	Fraunhofer IEE
GER	Peter Remmen	E.ON Energy Research Center
GER	Jonas Schorr	City of Berlin
FIN	Mikko Pihlatie	VTT
JP	Takao Sawachi	Building Research Institute
NL	Sjoerd van Dijk	Netherlands Enterprise Agency
NOR	Inger Andresen	NTNU
NOR	Danila Baer	NTNU
NOR	Steinar Grynning	NTNU
NOR	Gohari Savis	NTNU
NOR	Åse Lekang Sørensen	SINTEF
SWE	Kerstin Rubenson	RISE
UK	Fiona Goodenough	Scottish Cities Alliance
EBC/UK	Malcolm Orme	EBC Secretariat
EUWP/GER	Gudrun Maass	EUWP Chair
HPT / SWE	Monica Axell	Heat Pump Center
IEA / FRA	Kenneth C. Michaels	IEA Secretariat
REN21	Lea Ranalder	REN21
SHC/FRA	Daniel Mugnier	TECSOL SA
SHC/USA	Pam Murphy	SHC Secretariat

CONTENTS

SHORT VERSION	1
INTRODUCTION AND BACKGROUND	3
INITIAL SITUATION	3
IEA'S ENERGY TECHNOLOGY NETWORK	4
OBJECTIVES AND AIMS OF THE WORKING GROUP	5
WORKING STRUCTURE AND PROGRAM	5
Participation in the Working Group	5
WORK PROGRAM OF THE WGCC	6
OVERVIEW OF ACTIVITIES	6
Workshops and working meetings	6
Additional TCP exchanges and workshops	6
EBC ExCo participation	6
Additional representation activities	6
SUBGROUPS	7
RESULTS	7
Subgroup 1 - Technologies	7
Scope of Subgroup 1	7
Participants	8
Activities, results, achievements, and lessons learned	8
SUBGROUP 2 - STRATEGIES	
Scope of Subgroup 2	
Participants	
Activities, results, achievements, and lessons learned	
SUBGROUP 3 - DATA	
Scope of Subgroup 3	
Participants	
Activities, results, achievements, and lessons learned	
JOINT WGCC RESULTS	22
Country Information	
MATERIALS PRODUCED BY THE WGCC	
FINAL REMARKS AND CONCLUSIONS	33
LESSONS LEARNED IN THE WGCC	
DERIVED CONCLUSIONS AND REMAINING CHALLENGES	
EVALUATION AND FURTHER CONCEPT DEVELOPMENT	37
REFERENCES	
FIGURES	
TABLES	
ANNEXES	

SHORT VERSION

As cities are the largest consumer of worldwide energy resources and account for roughly an equal share of global CO2 emissions, they are deemed crucial actors in developing decarbonization strategies. However, they face quite extensive challenges when it comes to the transformation processes of their energy and mobility systems. The simultaneous consideration of different factors and selecting the best-fit solutions for cities' specific and individual prerequisites requires comprehensive skills, knowledge and resources, which are fairly often missing in smaller communities. There is an often highly dynamic environment with many further requirements that also leads to uncoordinated decision-making within cities and different stakeholder groups. While solutions are usually provided for a higher, strategic level, decisions at the urban scale can substantially impact individual approaches and technologies.

Several IEA TCP projects tackle urban issues. However, a holistic system approach and thorough consideration of non-technological aspects are currently missing. The integration of "urban issues" into IEA TCP research is a necessary step towards fully considering cities' non-technical needs that extend well beyond technical energy solutions. As there is no specific institutional format to deal with these "urban issues", the Working Group on Cities and Communities (WGCC) was established as an exchange format within the EBC TCP.

The Working Group aimed to

- provide a structure for information and experience exchange where learning from others is understood as adapting best-practice solutions to different scales and needs.
- identify bottlenecks that lead to specific research questions or initiate innovative solutions.
- directly communicate with cities on their needs, and, in turn, provide direct support.
- enable communities to reach their goals, generate new and innovative ideas, plan and implement those ideas, promote and improve city transformation and enable improved self-awareness and -appraisal of the local context and opportunities for future advancement.

Overall, 59 experts from 13 countries contributed to the results of the WGCC in several workshops. The discussions and exchanges were structured along with three thematic priorities:

- a) Technologies
- b) Strategies
- c) Data, tools and methods

a) There are already several decarbonization Technologies available which contribute to the transformation of cities' energy systems. The heating and cooling systems need to receive close attention as they are centralized on a local scale. In particular, district heating and cooling systems offer cost-efficient opportunities to integrate available renewable energy sources. But it became obvious that the development of technology-systems for decarbonization in cities is not just a matter of research on technologies and technology-systems. It has to include non-technological aspects such as legal framework conditions, social aspects, etc.

b) These challenges for cities require appropriate Strategies, which are directly related to integrated and transformational planning at the city and community scale. Considering energy as a holistic system rather than individual siloed technologies requires an in-depth rethinking of current processes. Integration and transformation of decarbonization aspects might be characterized as a "journey". Ultimately, energy aspects are fully considered, incentives for change are identified, knowledge is available regarding how planning affects energy demand, and energy is linked across infrastructure, housing, land use, and all types of mobility. Diverse needs, key steps, success factors, crucial participants need to be considered for holistic, integrated planning processes and to generated benefits.

c) The correct selection and use of the best available Data, tools and methods are critical aspects for developing suitable strategies, integrated planning approaches, decarbonization decision-making processes in cities (e.g. building greenhouse gas inventories) and the selection of the most appropriate technology. To identify and improve the role of data tools and methods, aspects such as application cases, data sources and processes, data hubs, data competence, roles of public/private actors and the language barriers between planners and energy experts were analyzed and discussed.

The Working Group activities showed the benefits of exchange activities amongst the different actors working in and with cities. Several models for an establishment of an exchange platform within the IEA framework were discussed, and finally, the Working Group members conjointly decided to develop a new TCP, called Decarbonization of Cities and Communities (DoCC).

The Strategic Plan and the Program of Work of the DoCC TCP were developed and presented at the End-Use-Working-Party in March 2020. Based on the feedback of interested countries, the final organizational model has to be clarified, and the formal decision of the IEA to launch the new DoCC TCP has to be made.

INTRODUCTION AND BACKGROUND

INITIAL SITUATION

Cities generate about two-thirds of global primary energy demand and account for approximately 70% of the energy-related CO2-emissions. As city populations grow and this demand is likely to increase further, cities will need to play a critical role in achieving global targets through a rapid reduction of greenhouse gas emissions and adapting to climate change (International Energy Agency, 2016). Sustainable development of urban areas is a challenge of high importance, as reflected in the European Commission's focus topics. The research and innovation programme "Horizon 2020" aimed to foster "Smart Cities & Communities" (European Commission, 2020a), while the upcoming programme "Horizon Europe" defines and funds the development of "100 Climate-Neutral Cities by 2030 - by and for the citizens" as one of five great challenges (European Commission, 2020b).



Figure 1. Carbon emission reductions 2013-2050; (International Energy Agency, 2016)

Despite this urgent need for greenhouse gas reductions and the extensive available funding, the transformation in cities mostly progresses slowly as they face quite extensive challenges when it comes to targeted and long-sighted energy and mobility system transformations. For example, challenges arise around developing suitable decarbonization strategies (implying a holistic approach), identifying effective implementation instruments (regulation, incentives, etc.) and considering and weighing costs and benefits. In addition, these challenges have synergetic effects, which need to be considered simultaneously. However, such a simultaneous consideration and the subsequent selection of the bestfit solutions for cities' specific and individual prerequisites require comprehensive skills, knowledge and resources, which are fairly often missing in smaller communities. Furthermore, these decision-making and planning processes occur in a highly dynamic environment and need to compete with a vast number of other urgent topics - with often higher priorities. This complexity regularly leads to uncoordinated decision-making within cities but also within different stakeholder groups. While solutions to these transformation activities are often provided at a higher, strategic level, decisions and implementation are undertaken at the urban scale, which may call for and apply substantially different individual approaches and technologies. Without appropriate knowledge or support systems that bridge a potential knowledge gap, this discrepancy can lead to inadequate transformation approaches or, in the worst case, to no transformation at all.

Several well-known initiatives are invested in supporting cities through knowledge exchange and information, such as the C40, ICLEI, Celsius and the Global Covenant of Mayors for Climate & Energy, and the national Smart Cities initiatives. In addition to these "networking" initiatives, small and medium cities seem to require additional tailored support, which may exceed those initiatives' scope. Examples include policy development and implementation or technological applications (such as their suitability, implementation and benefits for cities), which allow for properly structured urban developments.

While the challenge of sustainable development is global, implementation strategies at the city level are, to a large extent, local and can therefore vary by country in form and content. Hence, urban strategies need to reflect the particular context, preconditions (e.g. legal frameworks, planning culture, etc.), priorities, needs and the social environment.

IEA'S ENERGY TECHNOLOGY NETWORK

Research within IEA's Energy Technology Network is organized in Technology Collaboration Programmes (TCPs) that operate a range of ongoing projects (also known as Annexes or Tasks). Some of these TCPs have already made initial contributions to urban issues through a multitude of annexes. The EBC TCP made the most significant contributions within Annex 63 "Implementation of Energy Strategies in Communities", which can be considered to be the cradle of the DoCC TCP. The EBC repeatedly addresses urban issues (e.g., in Annex 73 "Towards Net Zero Energy Public Resilient Communities" or Annex 75 "Cost-effective Building Renovation at District Level"), but the focus is clearly on technical and building-specific projects2. Another example of city-related research is the INSMART project of the Energy Technology Systems Analysis Program (ETSEP). Their energy system generator "TIMES" is currently implemented in four cities to develop a comprehensive model for enhancing sustainable planning by addressing the current and future energy needs through an integrative and multidisciplinary planning approach. Finally, Task 18 "EV Ecosystems" of the Hybrid and Electric Vehicle (HEV) TCP captured practical experiences from cities, regions, and businesses that pioneered in advanced plug-in electric vehicle pilot programs. The emphasis was on local deployment initiatives and bottom-up policy-making, including public and private stakeholders.

Most other TCP tasks or annexes that touch upon urban issues predominantly do this in the form of policy recommendations, planning, modelling, evaluation or monitoring tool generation, or the development of governmental or utility promotion and support programmes.

Among others, these approaches examples such as

HPT	Annex 30 "Retrofit Heat Pumps for Buildings"
PVPS	Task 10 "Urban scale photovoltaic applications",
SHC	Task 63 "Solar Neighborhood Planning",
	Task 51 "Solar Energy in Urban Planning"
	Task 52 "Solar Heat and Energy Economics in Urban Environments"
ISGAN	Policy Insights
UsersTCP	Task 4 "Development of Improved Methods for Integrating Demand-Side Options in Resource Planning"
	Task 9 "The Role of Municipalities in a Liberalised System"
HEV	Task 8 "Deployment strategies"
	Task 9 "Clean city vehicles"

However, working on a communal or urban level requires a holistic system approach and thorough consideration of non-technological aspects, which are not sufficiently addressed in current IEA TCP

research activities. This issue was identified in several workshops and discussions, within the EBC TCP and in cross-sectoral meetings.

The Austrian Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (former Austrian Federal Ministry for Transport, Innovation and Technology) volunteered at the 80th EBC ExCo meeting in November 2016 to prepare a proposal on how the topic of "Urban Issues" could be considered within the IEA TCP research activities.

OBJECTIVES AND AIMS OF THE WORKING GROUP

The integration of "urban issues" into IEA TCP research is a necessary step towards a full consideration of cities' non-technical needs that extend well beyond technical energy solutions. More importantly, this integration also takes advantage of the full range of opportunities and implementation tools at the local level to develop solutions tailored to each community, thereby fostering the proper development of solutions for urban challenges. To contribute to this integration, the Working Group on Cities and Communities (WGCC) was established as a first of its kind innovative exchange format between different representatives from different countries, representing different levels and forms of governments, (funding and research) institutions and consultancies.

The Working Group aimed to

- provide a structure for information and experience exchange where learning from others is understood as adapting best-practice solutions to different scales and to own needs.
- identify bottlenecks that lead to specific research questions or initiate innovative solutions.
- directly communicate with cities on their needs, and, in turn, provide direct support.
- enable communities to reach their goals, generate new and innovative ideas, plan and implement those ideas, promote and improve city transformation and enable improved self-awareness and -appraisal of the local context and opportunities for future advancement.

The objectives of the Working Group on Cities and Communities were to incorporate energy and resources related urban perspectives and needs into the technologically oriented structure of the IEA TCP research and support the system integration of technologies and the linking of technologies in cities. A broad consensus exists that the future consideration of non-technological aspects is also essential to successfully support cities in their transformation processes. Hence, the WGCC aimed to generate research questions based on cities' real needs and support the practical implementation of research findings by providing services to cities (filling the gap between research and cities), thereby promoting transformation, enhancing internal processes, and building capacity and knowledge.

WORKING STRUCTURE AND PROGRAM

PARTICIPATION IN THE WORKING GROUP

Participation in the Working Group was open for all interested representatives of different levels and forms of governments, (funding and research) institutions and consultancies. In particular the participation of city representatives was aspired in the meeting host cities.

The following countries participated in Working Group meetings, teleconferences and document development: Austria, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, Switzerland, UK and USA.

The following TPCs participated on a regular basis: EBC, DHC, SHC, HEV. In addition, representatives from AMF, Bioenergy and HPT participated in special WGCC workshops.

See the full list of participants under the section "Participants list" (page ii and iii).

WORK PROGRAM OF THE WGCC

The proposed work program included the following work packages:

- WP 1: Analyses of cities' needs, Involvement of cities
- WP 2: Identification of research questions (for TCP research, for short-term projects and research within the Working Group
- WP 3: Implementation of short-term projects and research
- WP 4: Evaluation of two working years, Concept for extension of WGCC

OVERVIEW OF ACTIVITIES

WORKSHOPS AND WORKING MEETINGS

-	09. & 10.04.2018	Vienna
-	17. & 18.10.2018	Dundee
-	16. & 17.04.2019	Berlin
-	28. & 29.10.2019	Paris
-	16.04.2020	Digital
-	01.10.2020	Digital – closing meeting

ADDITIONAL TCP EXCHANGES AND WORKSHOPS

-	18.12.2019	Digital
-	09.01.2020	BMK Exchange
-	06.02.2020	Digital

EBC EXCO PARTICIPATION

- June 2018 Stockholm (WGCC presentation)
- November 2018 Wellington (WGCC presentation)
- June 2019 Gent (WGCC presentation)
- November 2019 Boulder (WGCC presentation)
- June 2020 Digital (TCP presentation)
- November 2020 Digital

ADDITIONAL REPRESENTATION ACTIVITIES

-	June 2018	IEA EBC/SHC meeting, Stockholm (presentation by Helmut Strasser
		and joint workshop with SHC)
-	July 2018	International Conference on Urban and Rural Energy and
		Environment, Jilin (presentation by Helmut Strasser)
-	February 2019	IEA Building coordination group meeting (WGCC status report by
		Sabine Mitter)
-	June 2019	IEA EBC Technical Day, Brussels (presentation by Helmut Strasser)
-	September 2019	End-use working party meeting (TCP presentation by Sabine Mitter)
-	November 2019	CERT meeting (TCP presentation by Sabine Mitter)

March 2020 End-use working party meeting (TCP presentation by Helmut Strasser)
 June 2020 IEA EBC Technical Day Webinar "Energy innovations for the city of tomorrow", Online (presentation by Helmut Strasser)
 November 2020 IEA EBC Webinar "The Science and Communication of Energy Efficient Indoor Environments", Online (presentation by Helmut Strasser)

SUBGROUPS

During the first working meeting, the participants conjointly discussed and defined the Working Group's thematic focus and narrowed down those cities' needs that should be addressed with the work of the Working Group. Based on this meeting, three interlocking and interdependent subgroups were developed:

- Subgroup 1: Technologies
- Subgroup 2: Strategies
- Subgroup 3: Data, tools and methods

Each subgroup developed an individual program of work and defined deliverables. During each working meeting of the Working Group, the subgroups met in parallel sessions to give presentations, discuss findings and define further steps.

RESULTS

The following section describes the activities and outcomes of the work in the subgroups.

SUBGROUP 1 - TECHNOLOGIES

Jacques Kimman, NEA (until April 2019) Helmut Strasser, SIR; (from April 2019)

SCOPE OF SUBGROUP 1

The Paris climate agreement aims for mid-century carbon neutrality. Multiple pathways exist to achieve substantial emission reductions. The frequently emphasized strategies highlight decarbonization as a significant contributor to the goals. In particular, the European Roadmap for a Low Carbon Economy 2050 showed the feasibility of reducing GHG by 80%. This assumption is mostly based on the power sector's deep decarbonization, and the electrification of final energy uses.

Cities offer some of the best opportunities for decarbonization. Sectors such as buildings, transport, water and waste have the most significant potential for high impact decarbonization investments. Yet, cities often lack the capacity to plan and implement decarbonized energy systems. Furthermore, cities need support in developing technology-portfolios, which fit the cities' unique prerequisites and needs. Hence, decarbonization technologies are best developed by experts but subsequently need to be discussed and transferred into implementation strategies at the local level. The WGCC intended to be a platform for exploring and developing these technologies and their integration into cities' energy and mobility systems.

PARTICIPANTS

Name	Affiliation	Country	Task
1 Helmut Strasser	SIR	Austria	Primary coordinator
2 Jacques Kimman	Netherlands Enterprise Agency	Netherlands	
3 Juho Kostiainen	VTT Technical Research Centre of Finland	Finland	
4 Niki Gaitani	NTNU - Norwegian University of Science and Technology	Norway	
5 Nina Mostegl	SIR	Austria	
6 Kate Palmer	Urban forsight	UK	
7 Werner Weiss	AEE INTEC	Austria	
8 Yoshiyuki Shimoda	Osaka Universtiy	Japan	

Participants Subgroup I - Technologies

ACTIVITIES, RESULTS, ACHIEVEMENTS, AND LESSONS LEARNED

The subgroup held two workshops to discuss cities' strategies for decarbonisation

Workshop - Cities' strategies

Presentations

- City of Emden 100% renewable energy and 100% climate neutrality
- Scenarios for Decarbonisation of the urban area of Vienna until 2050
- Energy neutral cities in the Netherlands
- Dundee's 2030 Low Carbon strategy

Furthermore, Subgroup 1 discussed the future role of electricity in the heat sector as decarbonized electricity will be an essential player in all decarbonization strategies at the local level.

Workshop - Technology strategies

- Appropriate strategies and technologies with great potential for promoting integration between supply and demand
- The role of solar thermal in Future Energy Systems
- Technologies and Solutions for Design and Operation of energy flexible neighbourhoods The contribution of ZEN Centre to the reduction of GHG emissions in the residential sector
- Hybrid Energy Networks
- Integrated Cost-effective Large-Scale Thermal Energy Storage for Smart District Heating and Cooling.
- How do responsive buildings contribute to Zero-Emission Neighbourhoods Networks?
- Hybrid and Electric Vehicles

Results

The following section summarizes the main findings of the workshops outlined above. These results contributed to the development of the new DoCC TCP.

<u>General</u>

 Allow for the contribution of technical TCPs to planning processes. Not all technologies can be mixed freely (restrictions) – integrating this knowledge into the planning process would be beneficial. The planning process creates the conditions under which technologies can be applied more easily in a context-specific surrounding.

- The TCPs' role is to contribute targeted information regarding different technologies (and their combination) for decarbonization strategies and quantify their impact on the cities.
- Thus, there is a need for a platform to
 - discuss different strategies
 - learn about available strategies and experiences
 - o identify the new role of cities to integrate new systems
- Potential further investigation for a better understanding of implementation mechanisms
 - How did decarbonization strategies and associated responsibilities develop (e.g. climate change manager in Dundee), and what are useful strategies for cities?
 - What is the role of district heating, solar, sector coupling, gas grids, big large-scale integration, etc.?
 - What is needed from the cities (engagement in different projects, etc.)?
- Ideas for potential further activities
 - Definition study and inventory
 - Cases and ongoing strategy on decarbonization in different cases/cities/regions + getting the story behind it
 - "Shopping list" for decarbonization strategies (recommendation for good practice and definition of success factors)
 - Short publication (regarding aspects and success factors behind decarbonization strategies)

Technologies and system approach

- District Heating (DH) systems are often the backbone of an urban energy system, although WGCC participants assumed "cultural" differences regarding the acceptance of centralized heating systems in Europe. Temperature-cascading and implementation of efficiency measures reduce the heat losses significantly. Decarbonization of heat supply in DH systems needs to be based on a bundle of resources. Scenario analyses and cost-optimization modelling showed that thermal solar energy would be able to cover around 10% of the future heat demand of DH-systems. Active project development and incentives were discussed, which could overcome the actual decrease in the solar thermal market. Compared to other technologies' cost-learning curves, it is expected that the specific costs of solar thermal systems will further decrease as soon as the solar market is growing. Large-scale storage systems can be cost beneficiary as they are necessary to cover peak-loads of a district heating system and contribute to the increase of solar thermal systems share.
- To increase implementation of Ultra Low-Temperature DH-systems (in new areas), project development and planning activities linked to energy planning for new development sites are required. Frameworks for cost calculation should be adapted to these systems' characteristics (e.g. longer depreciation-periods due to lower material-stress).
- Demonstration projects, including energy concepts based on exergy-approaches, showed that decision criteria usually include other aspects than pure direct investment costs. Price-stability, user-friendliness or level of innovation were also relevant. However, as costs are often the strongest criteria, others need to be actively considered in the decision-making process to increase their relevance. Improved evidence for these criteria helps to increase the confidence in them.
- The responsiveness of neighbourhoods regarding heat demand, storage and flexibility of buildings offer new opportunities for achieving the zero-emission-targets. However, relevant criteria are required for the assessment and the development of suitable planning criteria. Furthermore, the utilization of these benefits requires a defined operator of the heating system. A potentially active role of cities or other stakeholder groups (e.g., housing associations) in the

development of appropriate organizational models for operators needs to be discussed further. Additionally, "penalty-signals" improve acceptance.

- The Norwegian ZEN Research Centre on Zero Emission Neighbourhoods in Smart Cities presented their activities, including eight demonstration projects on a neighbourhood scale. The focus on the neighbourhood scale was determined by findings from previous projects with a focus on buildings. It turned out that the implementation on the larger scale is potentially cheaper than implementing zero-emission-energy concepts at the building scale.
- In addition, the "role" of neighbourhood scale projects to be developed amid the built environment must be considered. Through those extended boundaries of the neighbourhood, additional criteria might become relevant for energy planning. Taking the existing heating systems in the surrounding building stock into account might lead to an economically viable grid-based heating system, while the supply of the neighbourhood project alone would result in an individual heating system. Utilizing the existing potential of renewables or waste heat might define requirements for the new building sites' flexibility or storage capacities. Research projects should aim at developing sufficient, reliable criteria and processes for these assessments.
- In addition, further implementations require a discussion concerning the cities' role as an enabler of such processes. On the one hand, cities can provide sufficient information through heat-maps (including detailed, address-based spatial information on heating systems, heat demand, potentials of renewables, etc.). Furthermore, cities can use their role as the spatial planning authority for pre-defining (binding) heating system preferences (based on the heat-map), e.g. by determining energy zoning-plans. On the other hand, cities can provide "standardized "assessments based on the heat-maps and additional services for further development of the energy concept. Thus, cities would be due to a leading role in energy planning, similar to their role in the planning and development of other infrastructures, such as mobility, etc.
- Based on the EU-SET Plan, a European initiative promotes Positive Energy Districts (PED), aiming to build at least 100 PEDs by 2025. European and synchronized national funding programs aim to promote relevant research and accelerate the implementation of PEDs.

Ideas for linkages

- As discussed before, the realization of cost-effective solar thermal shares of around 10% requires an active role of cities and urban planning departments. Based on the defined decarbonization visions and goals regard, cities should use their full range of planning instruments and incentives to improve the implementation of solar thermal systems (sticks and carrots).
- Making use of the flexibility of neighbourhoods requires the definition of an operator for the whole system. Integrated planning processes might include an active role in the definition of such an operator.
- Energy planning should become a relevant part of urban planning. Therefore, cities should also lead these planning tasks (instead of supply companies, etc.). Thus, resources and knowledge within the city administration have to be generated. To successfully increase the capacities requires a deeper understanding of cities' needs (e.g. need to consider existing planning procedures, tools, etc.).

Potential for collaboration

 A new Task within the DHC TCP called "Hybrid Energy Networks" brings together experts from different TCPs, including ISGAN, EBC, SHC, ECES and HPT. Further collaboration is welcomed.

- Since decarbonization activities at an urban scale require extensive knowledge of city processes and their needs, a close, implementation-oriented cooperation with cities is crucial. This cooperation should mainly be organized at the national scale as planning cultures vary from country to country. Each participant of the Working Group is encouraged to be active in that sense.
- Planned European funding calls for PED are expected. Meanwhile, the EBC Program started Annex 83 "Positive Energy districts".

Through the activities of Subgroup 1, it became apparent that the development of technology-systems for decarbonization in cities is not just a matter of research on technologies and technology-systems. It has to include non-technological aspects such as legal framework conditions, social aspects, etc. Furthermore, it needs a regular exchange with the cities to understand their options, needs and challenges at the local scale.

SUBGROUP 2 - STRATEGIES

Carissa Slotterback, U of M (until April 2019) Nina Mostegl, SIR; Jacques Kimman, NEA (from April 2019)

The subgroup "Strategies" worked on issues related to the topics of integrated and transformational planning at the city and community scale. A key first step in advancing integrated and transformational planning is to develop a common and long-term vision/goal that all are driving toward. The vision/goal can be informed by broader climate change goals at the state, national, or international levels. Seeing energy as a system rather than as individual energy technologies can make it easier to connect energy to the broader focus of a city or community's vision. Internal stakeholder groups representing relevant disciplines and departments might convened to inform the vision/goal. Ideally, engagement should also connect government with academia, industry, and citizens.

Integration and transformation might be characterized as a "journey" wherein a city or community "matures" in moving initially from ad hoc or one-off efforts to opportunistic, then repeatable and managed efforts, and finally to an optimized system. Ultimately when integrated or transformational planning occurs, energy is considered in urban development, incentives for change are identified, knowledge is available as to how planning affects energy demand, and energy is linked across infrastructure, housing, land use, and all types of mobility.

The process of integrated and transformational planning might be characterized as such:



Figure 2. Integrated planning process (Figure developed during WGCC Workshop 9. & 10.4.2018)

In Figure 2, the vision can be tailored to the city or community and might include a focus on decarbonization, climate resilience, or other priorities. Importantly, transformation or transition is ongoing and requires iteration.

SCOPE OF SUBGROUP 2

Three guiding questions provided the basis for the work of subgroup 2:

- 1. How do we advance both integrated and transformative planning?
- 2. How can citizen and stakeholder involvement work properly?
- 3. How can we help the cities to ask themselves better questions and what are cities and communities uniquely positioned to do relative to other levels of government and other sectors?

Based on these questions, the subgroup aimed to

- gather and discuss international examples of integrated planning frameworks, methods, and processes.
- exchange with cities and communities that have implemented the frameworks, methods, and processes noted above.
- collect and structured cities' and their actors' needs (and associated stakeholder needs) with regards to integrated planning.
- determine success factors and aspects of integrated planning process.
- investigate potentials for decarbonisation strategies in cities.

PARTICIPANTS

Participants Subgroup II - Strategies

Name	Affiliation	Country	Task
1 Nina Mostegl	SIR	Austria	Joint coordinator
2 Jacques Kimman	Netherlands Enterprise Agency	Netherlands	Joint coordinator
3 Alessandra Scognamiglio	ENEA (Dipartimento Tecnolgoie Energetiche)	Italy	
4 Brita Fladvad Nielsen	NTNU - Norwegian University of Science and Technology	Norway	
5 Carissa Slotterback	University of Minnesota	USA	
6 David Beeton	Urban Foresight	UK	
7 Helmut Strasser	SIR	Austria	
8 Jens Freudenberg	Dt. Verband für Wohnungswesen, Städtebau und Raumordnung	Germany	
9 Maren Kornmann	ENCO Energie-Consulting AG	Switzerland	
10 Maria Wall	EBD	Sweden	
11 Marie Sevenet	Europaeisches Institut fuer Energieforschung, Universität Karlsruhe	Germany	
12 Niki Gaitani	NTNU - Norwegian University of Science and Technology	Norway	
13 Sarah Marchionda	Independent	Canada	
14 Uta Schneider - Gräfin zu Lynar	B.&S.U. Beratungs- und Servicegesellschaft Umwelt mbH	Germany	
15 Werner Weiss	AEE INTEC	Austria	

ACTIVITIES, RESULTS, ACHIEVEMENTS, AND LESSONS LEARNED

Organizational activities

As Carissa Slotterback, the leader of subgroup 2, suspended her participation in the Working Group, Nina Mostegl and Jacques Kimman lead the subgroup for the second phase, beginning in April 2019.

Content activities - Results

The subgroup

- 1. connected with city representatives in the meetings in Dundee and Berlin,
- 2. exchanged information through country specific presentations in the meetings in Dundee and Berlin,
- 3. gathered data on cities' needs through their networks
- 4. compiled a comprehensive presentation on cities' needs and a short, explanatory document related to this presentation (compiled in Annex I),
- 5. determined key steps, success factors, crucial participants and benefits of integrated planning processes in a subgroup workshop in Berlin,
- 6. drew conclusions about the necessary requirements for maturing in the development of integrated planning processes and decarbonization strategies, and
- contributed to the development of the TCP, more specifically to the topics of "Scenario development for strategic planning", "Financing", "Social aspects of (energy) planning" and "Mobility", and to Annex 3 Financing innovative business cases for decarbonisation in cities
- 1. Connect with city representatives in the meetings in Dundee and Berlin

These exchanges included representatives from the "Senatsverwaltung für Stadtentwicklung und Wohnen Berlin", Creative Climate Cities Berlin, Urban Impact Berlin, Scottish Cities Alliance and Climate Change Management Dundee.

2. Information exchange through country specific presentations

List of presentations:

- Needs of cities (Nina Mostegl) (Annex I)
- Integrated Planning (Carissa Slotterback)
- Systems of Systems Mapping (David Beeton)
- Integrated urban and Energy Efficient Development in Germany (Jens Freudenberg)
- Integrated planning works in Germany (Uta Schneider Gräfin zu Lynar)
- Integral urban development planning case study Germany (Uta Schneider Gräfin zu Lynar)
- Integrated urban and energy Planning in Germany "Innovation City" Model (Jens Freudenberg)
- The road towards energy neutral cities integral approach (Jacques Kimman)
- Integrating energy aspects in quarter planning (Nina Mostegl)
- 3. Data on cities' needs

Data was collected during and after meetings of the Austrian Smart City Network and through interviews with international city representatives (including Austria, Sweden, Netherlands, and Germany). In addition to the current approach, the existing bottleneck analysis of Annex 51 was used as a checklist to extend and complement the current challenges and approaches.

4. Presentation on cities' needs and explanatory document

Based on the collected data, Nina Mostegl delivered a presentation at Dundee's Working Group meeting (October 2018). The information provided in the presentation was supplemented by feedback from the subgroup participants and complied in a short, explanatory document, which accompanies the presentation (Annex I).

5. Key steps, success factors, crucial participants and benefits of integrated planning processes

Key steps

- (1) Get inspired (look at other examples)
- (2) Exchange (with others within departments and outside of the administration)
- (3) Facilitate (make use of all available strategies and regulations to facilitate integrated planning)
- (4) Develop new collaborations (within the administration and more importantly with new and ambitious stakeholders outside the administration; e.g. funding for innovation projects through pension funds)
- (5) Get to know the area well (socio, ecological, economic, functional, and technical criteria of the project and the surrounding area to guarantee the quality of planning)
- (6) Be brave and try new approaches (lighthouse projects such as innovation city)
- (7) Follow a plan such as the nine strategic measures for integrated planning, developed in Annex 63:

S	Set Vision and Targets
sure	Develop Renewable Energy Strategies
	Make Full Use of Legal Frameworks
lea	Design of Urban Competition Processes
Σ	Make Use of Tools Supporting the Decision Making Process
gic	Implement Monitoring of Energy Consumption and GHG Emissions
Ite	Stakeholder Engagement & Involvement
tra	Include Socio Economic Criteria
S	Implement Effective and Efficient Organisational Processes

Figure 3. Strategic measures for integrated planning (EBC Annex 63: Implementation of Energy Strategies in Communities Volume 2: Development of strategic measures)

Success factors

Success factors are associated with the presence of the key steps (including the strategic measures) and participants outlined in this document. The subgroup discussed in more detail the

- awareness of avoided costs (integrate the finance sector and raise awareness for their longterm costs; e.g. retrofitting project in the Netherlands (Jacques Kimman); measures in ISEK are linked to budget lines in the budget)
- innovative actors and business cases (an important aspect of the decision process is the willingness of investors to support the implementation. It turns out this willingness is very dependent on the economy of scale and often includes a public-private multiple business cases)
- appropriate tools that trigger the break-up process of silos and the facilitation of integrated planning (e.g. ISEK – Integrierte Stadtenwicklungsplanung / integrated spatial planning concept)
- strong networks of big players (e.g. innovation city; if there is a will, there is a way particularly in the political field)
- streamlining of processes (the lessons learned need to be translated and scaled)

"Wicked problems" of the integrated planning process

During the planning process, communities frequently encounter challenges and unanswered questions. The following list is comprised based on the comparison of German, Austrian and Dutch best practices.

- Conflicting objectives/interests
- Deviating long and short-term goals
- A dynamic state-of-the-art in technologies
- Fragmented budgets / departments / decision-making
- Fragmented / single-issue instruments
- Multiple problem owners and lack of coordination
- No cooperation between urban and energy planning public/private domains
- Unsuitable or hindering legal frameworks
- Old-established and conservative vs. new and innovative business (niche and regime players)
- Lack of financing during the conceptual phase
- Different needs and solutions for the various strata of the population (e.g., young and elderly, poverty-prone and wealthy, etc.)
- How can long-term goals guide the steering process?
- How can local initiatives fit into and be derived from regional and national strategies?

Participants

Key participants are needed at all levels of the city administration and at different decision-making joints of the planning process, which includes higher-level city representatives, politicians, and housing developers. Further, to anchor integrated planning concepts within a city and with relevant external stakeholders, a "care-taker" is required to take care of and facilitate knowledge exchange and enhancement.

(1) Representatives of operational level in the administration

Motivated people in the administration such as employees who feel responsible for and take action in a certain focus topic of the planning process and push this topic within the administration and with relevant higher representatives and politicians.

(2) Representatives of the higher level of the administration

As decision-making and directive issue authority, the representatives of the higher administrative level are required to instruct their employees to follow integrated approaches and to foster cross-silo exchanges.

(3) Politicians

A strong leverage on processes is ascribed to politicians. Integrated planning can only be enabled through sturdy support from this level and their understanding for the importance of cross-cutting approaches. If cooperation and joint projects are not supported, their initiation, execution, and achievement is not guaranteed.

(4) Housing developers, contractors, etc.

Interested, motivated, and open-minded developers are needed to cooperate with the different administrative levels. Business as usual will not lead to innovative and integrated projects.

(5) "Care-takers"

A crucial participant is the "care-taker", which is often missing in the current planning approaches. These "care-takers" are required to support the process and subsequently translate the lessons-learned and the information yield into adaptation approaches for future planning processes. These relevant stakeholders are therefore responsible for the scalability and streamlining of the planning process and for quality assurance by fostering and facilitating knowledge exchange and enhancement.

In addition, new expertise is required at all levels and within all key participants. "Innovation comes with new staff, which has new and innovative training (e.g. Master in integrated urban development etc.)

Benefits of integrated planning processes

In relation to the case studies, the subgroup discussed the following benefits. It needs to be mentioned, that more benefits exist and emerge dependent on the respective framing conditions of the individual planning process.

- Safeguarding of climate goals (no transmission losses of goals and approaches between planning and implementation departments).
- Long-term reduced costs (e.g., in the case from the Netherlands, the housing company invested since the value of their properties decreased. The payback-time was calculated with 25 years, which was an innovative approach for the developers.)
- Increased reputation for participants (e.g. housing companies, city lighthouse projects, etc.)
- Increased satisfaction and quality of living of users (e.g., nicer living conditions, improved aesthetics, stable renter stock, etc.)
- Increased area values (added value employment and companies, added property values)
- Improved (and new) cooperation with external stakeholder (increases the likelihood for further ambitious projects)
- Increased innovation (new business models e.g. developing from energy provider to service provider, stakeholders and approaches)

6. Conclusions about the necessary requirements for maturing in the development of integrated planning processes and decarbonization strategies

- Learn from innovators the integration and exchange with innovators needs to be expanded, as these players can shed a light on the reasons for investing in decarbonization. Particular focus should be placed on their benefits for advancing decarbonization strategies (e.g., progressive housing companies and investors). How can their approaches be scaled or transferred for other actors?
- Identify triggers for integrated planning the subgroup work discussed several triggers, but did not attempt an inventory (e.g. top down, agreements, grass-roots). A further investigation of circumstances that triggered integrated planning approaches or the development of decarbonization strategies could be useful in scaling these approaches and their associated benefits.
- Increase the knowledge transfer to cities during all conversation with planners and city
 representatives during the subgroup work, it became clear that maturing and fostering
 integrated planning and decarbonization strategies will only be possible through increasing
 the knowledge in cities. We have to create a need for these topics in the cities themselves
 and identify relevant entry points.
- Investigate innovative financing approaches in particular the conceptual pre-phase is often not financed. For the investments in inclusive business cases for district development, it should be possible to have a money flow between investors and users in order to unburden the inhabitants from high costs. Outstanding examples that aim to overcome challenges associated with financing and that may be transferred to other countries include:
 - German: KFW-bank that subsidizes a coordinator for municipalities.
 - o UK: bidding programme of 1000 M€ for district heating, 140 local authorities involved
 - Finland: MOTIVA, agreement between the government with banks to fund projects if they fulfil certain criteria
 - o Austria: Acceleration Programme for the implementation of district heating
 - The Netherlands: InvestNL, large-scale invest in project bearing the potential to solve societal challenges such as the energy transition. Increased payback time and lower risk than with common banks.

Remaining questions

- How can cities invest in planning tool innovation?
- Resources are a challenge in every administration. Only a short amount of time is invested in developing integrated approaches and decarbonization strategies. How and through which support can this time be used efficiently and this process optimized? What can be offered to cities?
- 7. Contribution to TCP

Based on the information gathered during the working period, the subgroup specifically compiled additional questions and contributed to the topics of "Scenario development for strategic planning", "Financing", "Social aspects of (energy) planning" and "Mobility", and Annex 3 Financing innovative business cases for decarbonisation in cities.

SUBGROUP 3 - DATA

Andreas Koch, EIFER; Marie Sevenet, EIFER

The subgroup investigated the use of data, tools and methods to support the development of strategies and integrated planning, and to better inform the decision-making process in cities. The supported processes are part of the local energy transition process and thus inscribed in the communities' decarbonization strategies (Subgroup 1). Integrated planning concepts (Subgroup 2) are part of the local energy transition process described as an outcome of IEA EBC Annex 51 (Figure 4).



Figure 4. Five steps of the local energy transition process (EBC Annex 51: Jank, 2017)

SCOPE OF SUBGROUP 3

The work on Data, Tools and Methods (Subgroup 3) supports Decarbonisation Strategies (Subgroup 1 - renamed to "Technologies") directly through methods (e.g., building greenhouse gas inventories) and indirectly via Integrated Planning Concepts (Subgroup 2).



Figure 5. Scope of WGCC Subgroups (Figure developed for the work plan subgroup 3)

EBC Annex 51 (Webster et al., 2013) described several functionalities and use cases for local planning at the scale of the municipality as well as the scale of urban areas or neighbourhoods. In the workshops in Dundee and Berlin that included city representatives and urban planners, further use cases were discussed to sharpen the orientation of the treated questions.

• It was concluded to use the scales of the whole city or municipality and the urban area as distinct application cases in the collection of tools, best practices and methods.

	Objectives	Applications	Example
Strategic Planning (Community, Metropolitan Area)	Strategic guidance to develop municipal planning policies Identify economic effects of LEP alternatives Monitor compliance with national targets	Municipal Emission Inventory Local energy efficiency strategy Development of local planning regulations or bylaws Assessment of local renewable energy resources	Bilan Carbone©, GHG Inventory (ADEME, France)
Local Planning Concepts (Urban Areas, Neighbourhood)	Guidance for specific project development Develop optimal systemic solutions for the local energy system Prove compliance with municipal or national regulations	Total GHG emission, primary energy or final energy balance for a project Comparing planning alternatives Cost optimisation for the different solutions	District Energy Concept Advisor, Building based energy assessment (Fraunhofer IBP, participating countries Annex 51)

Table 1. Data, tools and methods for different scales (Webster et al., 2013)

PARTICIPANTS

Name	Affiliation	Country	Task
1 Andreas Koch	Europaeisches Institut fuer Energieforschung, Universität Karlsruhe	Germany	Joint coordinator
2 Marie Sevenet	Europaeisches Institut fuer Energieforschung, Universität Karlsruhe	Germany	Joint coordinator
3 Alessandra Scognamiglio	ENEA (Dipartimento Tecnolgoie Energetiche)	Italy	
4 Brita Fladvad Nielsen	NTNU - Norwegian University of Science and Technology	Norway	
5 Dietrich Schmidt	Frauenhofer IWES	Germany	
6 Helmut Strasser	SIR	Austria	
7 Juho Kostiainen	VTT Technical Research Centre of Finland	Finland	
8 Niki Gaitani	NTNU - Norwegian University of Science and Technology	Norway	
9 Nina Mostegl	SIR	Austria	
10 Kate Palmer	Urban forsight	UK	
11 Ralf-Roman Schmidt	AIT	Austria	
12 Siri Joli	NTNU - Norwegian University of Science and Technology	Norway	
13 Yoshiyuki Shimoda	Osaka Universtiy	Japan	

Participants Subgroup III - Data

ACTIVITIES, RESULTS, ACHIEVEMENTS, AND LESSONS LEARNED

After defining the subgroup's scope in the first meeting, workshops with planners and energy experts were held during the second and third meeting in Dundee and Berlin. The inputs collected at these workshops guided the orientation of a future Annex in the DoCC TCP.

Definition of application cases

The following application cases were collected at the WGCC workshops:

- Evaluation / monitoring on a district / city level
 - Sensor (related to data)
 - o e.g. methodology for calculating KPIs (e.g. CO2 emissions) on a district level
 - o Annual vs. daily / hourly evaluation
 - Strategic planning at the city level
 - o Greenhouse Gas Emission Inventories
 - o Urban Heat Atlas
 - o Develop different pathways for (decarbonization) strategies
 - o Selection of KPIs
- Participation
 - o Allow interactive exchanges between cities
 - o Discussion forums, etc.

Data Sources & Processes

Planning processes are fragmented within the municipality and between related service units or service providers (energy, mobility, network operator, developer, etc.). Often, data is sector specific but not sufficiently structured. In addition, data is frequently described as fragmented and inconsistent. From the technical infrastructure point of view, several sources (e.g., sensors or home energy management systems) can be named. The discussion in the 3rd workshop focused on the necessary processes and framework conditions to collect and use data to inform decision-making.

Especially the issue of incentives for data providers and the possibility to pass by-laws to ensure the collection or availability of certain data types were discussed.

The application cases need to consider data protection regulation as well as privacy issues.

- In the discussion, relevant application cases were cited. The description of standard data models and data management in communities seems less clear. The DoCC TCP can help to overcome this issue by defining standard use cases or gather national examples of such processes.
- Often, data sources and processes are known. Yet, many participants pointed at the lack of processes to manage the data and make use for the benefit of the citizens.

Data Hub, Portals & Application

During the 3rd workshop, the Open Data Portal of the City of Berlin was presented. At different points in the discussion, a differentiation between data porta(s) and applications was made. In addition, several cities, such as Hamburg, introduced the concept of data hubs. The open data portal focuses on serving a certain kind of data defined by the license type as open data. A data hub is seen as an overarching structure that connects different data sources containing available data from a wide range of sectors. Tools or applications are specific to the use case and do not aim at the holistic coverage a data hub holds.

Applications

Specific challenges regarding tools and methods concern the need for standard assessment methods and compatibility of interfaces or data models. Future research should focus on existing initiatives proposing the standardization of methods and data. Examples are Inspire in Europe or the OGC's CityGML standard for semantic urban building models.

• Relevant outcomes could be the assessment of the value created for municipalities, utilities or service providers as well as the transferability of the concepts.

Past collections of tools (e.g., EBC Annex 51) show the difficulty of creating relevant categories to describe decision support tools for urban planning. Tools range from simulation and optimization to visualization of data or scenario building models.

• The Working Group shall develop distinct use cases and clear categories to support the classification of tools applied in integrated urban planning. In this way, the multiple applications developed in the related TCPs can be communicated clearly towards municipalities.

Public vs. Private Actors

With diverse actors involved in the planning and decision-making processes, it is unclear which actors best fulfil the roles of managing data hubs or providing it based solutions. The discussion did not clarify if public or private entities are more suitable for managing data stocks. A certain consensus exists on the necessity of trust regarding the data collection and quality of data. Therefore, transparent processes are necessary and actors with no direct economic interest seem to be better suited to manage data portals or hubs for cities. Different solutions were discussed regarding the price of data services. In the case of Berlin, the city charges a service fee for preparing specific requests, while data is provided free of charge via, e.g. FIS broker.

Data Competence

Ensuring and improving data competence in administrations at all levels was seen as a prerequisite for introducing new ways of using data in planning. While data competence is needed to master tools and methods at the application level, competencies are also needed at higher hierarchical levels to promote and stimulate the introduction or test of new tools and methods.

At the same time, administrations face competition with the private sector for the needed competencies. There is no level playing field in the development and use of data-driven applications under current conditions.

Make Cities Better!

One apparent issue, which emerged from the discussion, is the different language used by planners and energy experts. It was stressed that the identification of common objectives is a necessity to allow for a constructive dialogue. To put it bluntly, the goal of "making cities better" has the difficulty of incorporating different interpretations of the means necessary to achieve it. Therefore, while technical solutions might be critical for some actors, the selected indicators for city administration are often specified differently. Eventually, common targets should be defined to harmonise the differences in language that became apparent in the presentations of scientific and administrative tool users.

JOINT WGCC RESULTS

All Working Group meetings focused on discussions on the different goals, responsibilities, funding opportunities and approaches to decarbonization in the countries. Based on the initial idea of expanding the Working Group into a TCP, the participants carried out a country comparison on decarbonization. The aim of this comparison was firstly to identify the responsibilities and important decarbonization issues in the countries, and secondly to clarify the potential for the development of a new TCP. A template was prepared, which was filled out by the participants individually for their country. The returned and filled-out templates are listed on the following pages.

COUNTRY INFORMATION

Austria

Are there specific national goals formulated in regards to cities and decarbonisation?

Task 8 in Mission 2030: Make urban and rural areas more climate-friendly

Promote smart cities, which have a vital role in climate protection and energy system transformation. Objectives are functional, climate-conscious, energy-efficient and low-input communities, which shall be achieved through sustainable urban development. Urban planning, infrastructure planning, network planning, land use planning and energy planning processes must therefore be developed at all levels of local/regional government.

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Federal Ministry for Transport, Innovation and Technology (BMVIT):

Implementation plan for bmvit relevant mission 2030 aspects and topics including "plus-energy districts", "buildings and urban systems", and "mobility". Links to Mission innovation and SET-plan. Responsible for the Austrian Smart City Network with the goal of linking the ministry to cities.

Federal Ministry for Sustainability and Tourism (BMNT):

Program "klimaaktiv" for communities (e5 program / European Energy Award). klimaaktiv tool "site certification". Heating strategy (under development).

In your opinion, which ministry could be responsible for the new TCP? Federal Ministry for Transport, Innovation and Technology (BMVIT)

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

No, as the TCP aims for innovation, which is a clear competence of the bmvit. Decarbonization, urban systems and city scale aspects als also in the competence of the bmvit. The competences for implementation projects depend on the frame of the projects and the harmonization with an implementation-funding scheme may pose a challenge.

List available national funding programs for potential annexes of the TCP.				
 PEDS: City of the future (SDZ) JPI Urban Europe Smart City Demo 	System integration: City of the future (SDZ) Smart City Demo Mobility of the future (MDZ) Zero Emission Mobility 	Scenario devel. for strat. planning: • Potential direct commission		
Data, tools, and methods: • Energy research (Energieforschungsprogramm) • Vorzeigeregion Energie • City of the future (SDZ)	Spatial (energy) planning:Vorzeigeregion Energie	Financing:Energy transition 2050Green Finance		
Social aspects of (energy) planning: • Energy transition 2050	Others:			

•	Austrian climate and research	In addition	n, there a	are mu	ltiple implementatio	n fundings av	ailable for the
	program	thematic	areas	(e.g.	electric-vehicles,	renovation,	renewables,
•	Mobility of the future (MDZ)	greenstar	t)				

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

Knowledge collection and dissemination preparation

The annex/secretariat task aims to collect the existing knowledge in IEA TCPs and lays the foundations for knowledge dissemination to the cities (structure, etc.)

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

No concrete annexes descriptions yet, but ideas could be developed and supported for PED development, the establishment of spatial energy planning as harmonized tool, site certification, and scenario development for strategic planning (e.g. role of electricity in the future heat market).

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Yes. The bmvit funds the Austrian Smart City Network and continuously encourages the exchange of the platform with other international networks. Bmvit is also engaged in the SET plan development. Bmvit also has a separate IEA budget reserved for relevant activities and TCP participation.

List potential country representatives (institutions, network coordinators, etc.).

Austrian Smart City Network / SIR

e5 – European Energy Award Network / SIR

Finland

Are there specific national goals formulated in regards to cities and decarbonisation?

No specific goals addressing cities, however individual municipal plans embrace the majority of population in Finland. Overarching national goal present and currently under discussion in each sector (https://www.ym.fi/en-US/The_environment/Climate_and_air/CarbonNeutral_Finland_2035).

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Voluntary network of cities Towards Carbon Neutral Municipalities run by the Ministry of the Environment https://www.hiilineutraalisuomi.fi/en-US/Hinku, https://www.hiilineutraalisuomi

In your opinion, which ministry could be responsible for the new TCP?

Ministry of the Environment (https://www.ym.fi/en-US)

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

Ministry of the Environment, Ministry of Transport and Ministry of Economic affairs would need to be engaged and cooperate

List available national funding programs for potential annexes of the TCP.			
PEDS:	System integration:	Scenario devel. for strat.	
• n/a	• n/a	planning:	
		● n/a	
Data, tools, and methods:	Spatial (energy) planning:	Financing:	
● n/a	• n/a	• n/a	
Social aspects of (energy)	Others:		
planning: • n/a	There are no separate funding prog appropriate funding programme fo <i>Business Finland and Smart Otanie</i>	ramme for different areas. The most or the TCP are: <i>Finnish Academy,</i> <i>mi</i>	

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

Join procurement process, Integrated cross sectorial planning municipal planning, Governance models, Managing city development process (multi-stakeholders oriented approach bridging different ambitions and goals)

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Yes, for instance energy and transport matters are not only a national matters and market is international. In this regard, it is important to cooperate and learn from each other, piloting solutions in different municipalities also outside Finland

List potential country representatives (institutions, network coordinators, etc.).

VTT, Energiateollisuus (Energy industry association), Kuntaliitto (association of Finnish municipalities)

France

Are there specific national goals formulated in regards to cities and decarbonisation?

- 1. Mitigation objectives
 - to achieve carbon neutrality by 2050, i.e. zero net emissions on the national territory
 - to reduce greenhouse gas emissions by 40% in 2030 compared to 1990
 - in the short and medium term, to comply with the carbon budgets adopted by decree
- 2. Adaptation objectives
 - to increase the share of renewable energy to 23% of gross final energy consumption in 2020 and to 32% in 2030. To reach this target, renewable energies must account for 40% of electricity production, 38% of final heat consumption, 15% of final fuel consumption and 10% of gas consumption by 2030.
 - to -17% in 2030 for the decrease in final energy consumption and -40% in 2030 for the decrease in fossil primary energy consumption.

At municipality level, main targets are focused on network design and reducing urban sprawl

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Has to be confirmed

ADEME (French Environment & Energy Management Agency)

PUCA (Plan Urbanisme Construction Architecture)- interministerial body for research and experimentation under the supervision of the Ministries of Ecological Transition and Solidarity, Territorial Cohesion and Relations with Local Authorities, Culture and Higher Education, Research and Innovation.

In your opinion, which ministry could be responsible for the new TCP?

Ministries of Ecological Transition and Solidarity

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

List available national funding pro	grams for potential annexes of the	TCP.
PEDS:	System integration:	Scenario devel. for strat.
ADEME/ANR	ADEME/ANR	planning:
		ADEME/ANR
Data, tools, and methods:	Spatial (energy) planning:	Financing:
ADEME/ANR	ADEME/ANR	None
Social aspects of (energy)	Others:	
planning:		
ADEME/ANR		

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP See DoCC documents

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Yes but they are conducted a study on the current participation in TCP and Annexes to assess the need to follow up participation

List potential country representatives (institutions, network coordinators, etc.).

Michel Viktorovitch Ministère de la transition écologique et solidaire Direction Générale de l'Énergie et du ClimatDGEC/DG Chargé de mission pilotage R&D nouvelles technologies de l'énergieTour Séquoia - 92055 La Défense Tel : 01 40 81 96 63

Germany

Are there specific national goals formulated in regards to cities and decarbonisation?

Yes, National climate protection strategy

Please list all ministries and their program strategies, which may be relevant for the new TCP.

BMI (Interior, including responsibility on territorial development and construction), BMU (environment, responsibility for climate protection) BMWi (Economy and Energy, responsible for energy efficiency strategy and relations to IEA)

In your opinion, which ministry could be responsible for the new TCP? BMWi

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries? No, TCPs are considered to be IEA related R&D and do not influence real politics

List available national funding programs for potential annexes of the TCP.		
PEDS:	System integration:	Scenario devel. for strat.
● n/a	• n/a	planning:
		• n/a xx
Data, tools, and methods:	Spatial (energy) planning:	Financing:
• n/a	• n/a	• n/a
Social aspects of (energy)	Others:	
planning:	only the energy research funding of BMWi will be eligible, because all IEA	
• n/a	related activities are under the responsibility of BMWi	

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

Analysis of national contributions to all TCPs and annexes until now to detect priorities, special focus and may be deficits

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Yes, is done regularly

List potential country representatives (institutions, network coordinators, etc.).

Depends on German contribution via national R&D projects

Netherlands

Are there specific national goals formulated in regards to cities and decarbonisation?

50% reduction in 2030 and 100% in 2050

Coalition Climate Agreement:

30,000-50,000 houses without gas/year; No natural gas for new houses; Existing houses->District-oriented approach

District tender (120 million) Municipalities (& grid operators & end-users) Results 1st tranche: 27 allocated Innovation tender (12.8 million)

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Ministry of Economic Affairs and Climate, responsible for the energy system and the circular economy. Goal is 50% reduction in 2030 and 100% in 2050.

Ministry of Internal Affairs, responsible for the built environment. Same goal, but more inclusive approach (emphasis on quality of living, pay ability for the inhabitants and robustness of solutions).

Ministry of Infrastructure and Water, same goal but more emphasis of integral environmental laws, (water)infrastructure and mobility.

In your opinion, which ministry could be responsible for the new TCP?

The Ministry of Economic Affairs is coordinating and has the final responsibility for international cooperation but the Ministry of Internal Affairs is the most involved with respect to the content.

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

There is a strong overlap (energy infrastructure/built environment) and in principle there are some conflicts, but in the Netherlands we try to coordinate these tensions in all kind of integral steering groups.

List available national funding pro	grams for potential annexes of the	TCP.
PEDS:	System integration:	Scenario devel. for strat.
 District tender Facilitation of IEA-activities Mission driven innovation programs (MOOI) ECW (expertise centre heat) 	 Program System Integration Smart Cities Green Deals	planning:supporting programs for the regional energy strategies
Data, tools, and methods:	Spatial (energy) planning:	Financing:
 see above, supporting programs for the regional energy strategies (RES) 	 supporting programs for the regional energy strategies 	Investment programs of RVO in cooperation with Invest.nl
Social aspects of (energy)	Others:	
planning:	Natural Gas Free District Learnir	ng Program
 MVI (societal responsible innovation) 		

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

To analyse the learning experiences in the different countries in terms of similar frameworks as developed in Annex 63. To integrate the existing knowledge on a system level and identify white spots and bottle-necks for further research. To analyse and find best practices for connecting to decision makers.

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

Tools for the decision makers, including investment schemes, pay-back times, business-cases and the most cost-effective energy system (given the boundary conditions of the given district) on the short and the long term.

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Very important, to fill in white spots in the Dutch knowledge landscapes, to initiate cross-border projects and the learn from other countries with other boundary conditions and other cultures.

List potential country representatives (institutions, network coordinators, etc.).

Netherlands Energy Agency, Ministry of Internal Affairs, TNO, Association of Municipalities, Invest.nl

Norway

Are there specific national goals formulated in regards to cities and decarbonisation?

Norway's Climate Strategy for 2030 – emission reduction goals for each sector, with focus on the transport sector, Green shift strategy, BYgg 21/ Building 21- a research strategy for buildings and communities, requirements for low emission buildings in the building code, ban for fossil fuels in all buildings from 2020, and on construction sites from 2023. The energy sector and the building sector already with low emissions.

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Ministry of Climate and Environment (KLD): 40% reduction target, goals for Enova, Circular economy strategy

Ministry of Local Government and Modernisation (KMD): guidelines for "plus-energy" houses and districts", Ministry of Education and Research (KUD): The Research Council of Norway, Energy 21-strategy 2018: Mission Innovation, IEA,

Ministry of Petroleum and Energy (OED): Links to Mission innovation and Energy 21

In your opinion, which ministry could be responsible for the new TCP?

Ministry for Education and Research – RCN

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

Possibly overlaps, as the TCP aims for innovation and research funding which is a competence of the RCN, decarbonisation and innovation projects, which is a competence of KLD/ Enova; urban systems – competence of OED and city scale aspects – competence of KMD.

List available national funding programs for potential annexes of the TCP.		
Enova	EnergiX	
Data, tools, and methods:n/a	Spatial (energy) planning:Long term planning for cities	 Financing: Innovasjon Norge The Research Council of Norway Nysnø
Social aspects of (energy) planning: • n/a	Others:	

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

Support proposal on "Knowledge collection and dissemination preparation of existing knowledge"

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

No concrete annexes descriptions yet, but ideas could be developed

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Yes. The RCN has the separate IEA budget, and funding exchange with different international networks.

List potential country representatives (institutions, network coordinators, etc.). Enova ZEN research program Bygg 21

Sweden

Are there specific national goals formulated in regards to cities and decarbonisation?

Yes, these are integrated in National Climate law and synchronise with Agenda 2030 goal 11- Sustainable Cities and Communities

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Ministry of Infrastructure Sweden and Swedish Energy Agency

In your opinion, which ministry could be responsible for the new TCP?

Ministry of Infrastructure and Swedish Energy Agency

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

No, the Ministry of Infrastructure in Sweden have responsibility for IEA Collaboration and Swedish Energy Agency is responsible for IEA TCP collaboration.

List available national funding programs for potential annexes of the TCP.		
PEDS:	System integration:	Scenario devel. for strat.
Strategic Innovation Program - Viable Cities	 Smart Energy Systems /Regional Energy Systems 	planning: • n/a
Data, tools, and methods:	Spatial (energy) planning:	Financing:
SWEA's Digitalization Program	● n/a	● n/a
Social aspects of (energy)	Others:	
planning:	• n/a	
 Research program Human, Energy Systems and Society (MESAM) 		

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

Overview of national goals , strategies on Smart Sustainable Cities in the Member Countries , develop IEA DoCC strategy and link it to WEO

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

Develop a new model on the collaboration with other relevant TCPs

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

Yes, regularly to support national participants to join on international collaboration

List potential country representatives (institutions, network coordinators, etc.).

Swedish Energy Agency / Viable Cites Program Director / other National experts as Operating Agents

United Kingdom

Are there specific national goals formulated in regards to cities and decarbonisation?

To our knowledge there are no specific national goals for decarbonisation at a city level. There is a national target that the UK should be net zero from 2050 (this was agreed in 2019). Most transport targets at a city level are driven by EU air quality targets.

It's also worth noting that transport is a devolved power, therefore there is an agreement that municipals fleets in Scotland must be 100% electric by 2025.

Several cities across the UK have signed up to the Covenant of Mayors.

Please list all ministries and their program strategies, which may be relevant for the new TCP.

Business, Energy and Industrial Strategy

Transport

Housing, communities and local gov

In your opinion, which ministry could be responsible for the new TCP?

Business, Energy and Industrial Strategy

Do you see potential overlaps/conflicts regarding the responsibilities of the different ministries as the envisioned cross-cutting TCP may relate to the competences of different ministries?

There are challenges working across different departments, departments are making more of an effort to join up strategy.

List available national funding programs for potential annexes of the TCP.		
PEDS:	System integration:	Scenario devel. for strat.
● n/a	● n/a	planning:
		• n/a
Data, tools, and methods:	Spatial (energy) planning:	Financing:
● n/a	● n/a	● n/a
Social aspects of (energy)	Others:	
planning:	n/a	
• n/a		

Please list ideas for an initial collaborative annex or task for the secretariat – this should be a joint activity of all participating countries and support the launch of the TCP

Developing a framework to benchmark city progress against a maturity model. This framework could differentiate by topic e.g. transport, buildings etc. This will incorporate learning from different cities to understand how strategy and policy have played a role in progress.

List additional ideas for annexes / potential projects that may be conducted based on goals, programs and funding in your country in the TCPs' thematic areas.

Scotland is support Local Community Energy creation, understanding systems at this level would be an interesting annex. Decarbonisation of transport is a clear-cut goal that is supported at a national level, projects could focus on decarbonisation of public transport and municipal fleets.

Is (inter-)national networking perceived an important asset in the respective ministries, and in which sense?

International collaboration and using best practice is actively encouraged within government departments within the UK. This is to ensure decarbonisation supports economic activity through industry.

List potential country representatives (institutions, network coordinators, etc.).

Committee on Climate Change

Future Cities Catapult

MATERIALS PRODUCED BY THE WGCC

- Cities' needs (presentation and accompanying document; Annex I)
- DoCC TCP Strategic Plan (Annex II)
- DoCC TCP Program of Work (Annex III)
- 4 Annual reports
- 6 Status reports
- EBC News 2019
- Homepage (https://www.iea-ebc.org/working-group/cities-communities)

FINAL REMARKS AND CONCLUSIONS

LESSONS LEARNED IN THE WGCC

The IEA-EBC Working Group on Cities and Communities was a direct derivation of results from the IEA-EBC Annex 63 (Implementation of Energy Strategies in Communities, http://annex63.iea-ebc.org). Throughout the working period, the Working Group tested and discussed assumptions and hypothesis from the annex, and we summarize the following lessons learned:

- ⇒ The annex identified a gap between scientific knowledge and its implementation in cities. It concluded that cities do not automatically find crucial information or targeted solutions and instead need to be directed to this knowledge by intermediaries. In addition, these intermediaries are critical advisors when cities encounter problems or bottlenecks in their implementation process. The WGCC aimed to provide a network and platform for information exchange to such intermediaries. We learned that the advantages of those exchanges are a new and more in-depth understanding of the participants regarding
 - where and which information to collect
 - who other leading experts are in the field and
 - various solution approaches to recurring challenges in cities ("mention a problem, somewhere in the world this problem already has been solved").

Thereby, the Working Group expanded the list of best practices and added additional information to the results of Annex 63.

- ⇒ A hypothesis that has been widely discussed in Annex 63 was that solution approaches are often not transferable from one country to another as boundary conditions often vary significantly. An even lower transferability was assumed for city approaches. However, the discussions and comparisons in the Working Group regarding decarbonization strategies, the application of methods or the implementation of technologies clearly showed that - at least for the governmental and intermediary level - the opposite is true. Those stakeholders are able to derive targeted solutions from best practices and identify those boundary conditions that need to be changed to make the measures more effective.
- ⇒ Especially since the Paris Agreement's adoption, the energy transition has received increased attention in many countries. Over the past years, the analysis of lessons learned and best practices has become a highly dynamic process, with new information emerging daily. By comparing various best practices in the Working Group, we learned that collecting and distributing information regarding their approaches alone is insufficient to promote the transformation. In addition to the

process, the background story behind the best practices is essential to provide practitioners with sufficient information to scale solutions to their boundary conditions. Examples of background information include the

- initiators (who took the initiative and why?)
- decision-makers (who were the crucial decision-makers? What arguments were necessary for their approval?)
- process (how did the city organize the development process? How was the implementation organized?)
- strategies (which strategies were developed prior to the decision? What goals does the strategy aim to achieve?)
- stakeholders (which and how were they involved? How did a city manage and organize public support?)
- investors (who were the investors? What were their intentions for investing in decarbonization approaches?)
- ..., etc.
- ⇒ Although the Working Group's premise was to connect experts on the various topics related to cities' needs, in hindsight, it was of high value to divide the WGCC participants into three subgroups. The first part of every Working Group meeting consisted of mutual exchange and presentations of the subgroups' results to all peers. In parallel sessions, the subgroups could then consider their next steps after receiving feedback from the entire group. This approach proved to be highly successful and was very helpful for 1. the thematically concentrated exchange of experts, 2. the broadening of the view on one's field of work and 3. the exchange of information between the subgroups. We learned that all three subgroups are highly intertwined and regularly impact and influence each other. Interestingly but not surprisingly each of the subgroups was convinced that they were the guiding and driving force for decarbonization and transformation in cities.
- ⇒ Subgroup 1 learned that the development of technology-systems for decarbonization in cities is not just a matter of research on technologies and systems. Non-technological aspects (e.g., legal framework conditions, social aspects, etc.) are of high relevance for the broad application of technologies and only through a regular exchange with cities on their options, needs and challenges can we develop evidence-based solutions.
- ⇒ Subgroup 2 learned that key steps, success factors, crucial participants and benefits of integrated planning processes can be distilled from best practice examples and that all stages of a formalized process are necessary to change organizational structures and foster decarbonization in cities. The pending question is, how do integrated planning processes fit between vision and transformation (transition)?
- ⇒ Subgroup 3 learned that extensive research on data exists in a multitude of Annexes. Still, gaps and questions remain, whose analyses are deemed crucial to increase our understanding of barriers related to collecting, using and distributing data, tools and methods in cities. We do not lack innovative tools, but we are currently unsure of their most suitable selection process to support planning and implementation and ways of integrating knowledge into existing planning instruments (translation of information).
- \Rightarrow Finally, we learned that we still have a variety of essential questions that need to be addressed:
 - How can we broadly transfer existing knowledge (research and models) to cities?

- How can we help cities prepare for and embrace emerging "mission-driven" innovation?
- How can cities deal with rebound effects?
- What is the role of the different levels of the government (national, regional, local)?
- How can we better deal with multiple scales, time, and space?
- How can local strategies contribute to the overall (national) goals?
- How can we successfully link the nationally and regionally-specific strategies with appropriate technologies?
- How does decarbonization relate to other goals (e.g. sustainability goals, smart city, circular economy, etc.)?
- How can we incorporate uncertainties (risk) in local decision-making?
- How can the monitoring of decarbonization goals be better integrated into the planning process?
- How can planning processes integrate backcasting and forecasting (tools, methods)?
- How could a holistic assessment tool to optimize the inclusive impact and avoid sub-optimal solutions work?
- What makes cities a best practice example? What are the game-changers?
- How can different strata of the population and other external stakeholders be effectively involved in the transformation (e.g., young and elderly, poverty-prone and wealthy, etc.)?

DERIVED CONCLUSIONS AND REMAINING CHALLENGES

Based on the lessons learned above and the results from all three subgroups, the Working Group conjointly derived the following conclusions and remaining challenges for decarbonization in cities and communities:

1. Decarbonization is not yet a top priority in cities

Cities are a melting pot of diverse needs and offers and are required to provide all necessary services of general interest. The administration and development of consecutive topics, such as housing, infrastructure development, sustainable use of land, mobility, urban poverty or air quality as well as newly emerging topics, such as rapid digitalization, integration of migrants and refugees or job and skill creation in the local economy, often overshadow decarbonization in importance.

2. It is unclear how to approach and achieve decarbonization

While the challenge of sustainable development is global, implementation strategies at the city level are, to a large extent, local and can, therefore, vary by country in form and content. Hence, urban decarbonization strategies need to reflect the specific and unique context, preconditions (e.g. planning culture, legal frameworks, etc.), priorities, needs, and the social environment of the relevant city. However, there are currently no concrete concepts on how to approach decarbonization. In addition, the development of energy transition strategies is mostly unrelated to the actual implementation of innovative technologies. Subsequently, barely any energy and mobility system transformation processes exist that are based on the development of suitable decarbonization strategies (implying a holistic approach), the identification of effective implementation instruments (regulation, incentives, etc.), and the evaluation of costs and benefits.

3. Decision-making for decarbonization is a complex task and requires an integrated approach

Decision-making, planning, and the selection of the best-fit solutions for decarbonization take place in a dynamic environment and need to simultaneously consider a variety of aspects and interconnected goals (local economy, education, health, employment, circular economy, etc.). This integrated decision-making requires comprehensive skills, knowledge, and resources, which are often missing in smaller communities. This is aggravated by high complexity and uncertainty associated with innovative technologies, the combination of technologies, and the practical impact of implementation measures, which regularly leads to uncoordinated and fragmented decisionmaking within cities but also within different stakeholder groups. Even larger cities are mostly lacking an integrated planning process and are often unable to evaluate leading-edge technologies and current national and international knowledge. A strong link is needed between policy development and decision-making for concrete investments in energy infrastructure and technologies – whereby, ideally, the citizens are involved.

4. Decarbonization is often only associated with technological advancement and solutions

Decarbonization is naturally linked to the further development and optimization of individual technologies. This approach has been pursued extensively over the last few years, especially in the research community. However, successful decarbonization requires more than a focus on technological aspects. In addition to the current efforts for technological progress, non-technological issues need to be taken up, addressed and integrated. These approaches include, for example, the organization of the implementation of solutions, tendering procedures, financing, public support, public-private partnerships etc.

5. Decarbonization requires a sufficient appropriation of financial resources

Decarbonization efforts will require extensive financial resources and therefore immediate shifts in the investment behaviour of cities and large private and institutional investors. This aspect discourages bold approaches to decarbonization. Unlocking the necessary financial resources remains a challenge and will not take place without appropriate policies, regulatory frameworks, and innovative financial mechanisms.

For each of these barriers, a large number of studies, findings, and in-depth knowledge exists. However, this knowledge is only occasionally made available for cities and rarely disseminated in a way cities can immediately implement. What is therefore still missing is a holistic approach that supports cities not only in overcoming a single barrier, but is dedicated to informing, improving and expanding decarbonisation processes as a whole and aims to integrate urban needs into outstanding research approaches.

Within the working period of the Working Group it became clear that fulfilling those objectives requires more resources as well as formal structures, which cannot be provided sufficiently by a voluntary working group. Following motivating and fruitful discussions with the End-use Working Party in 2019, the working group members conjointly decided to develop a new TCP, named "Decarbonization of Cities and Communities" (DoCC).

EVALUATION AND FURTHER CONCEPT DEVELOPMENT

At the Working Group meeting in April 2019, the progress of the Working Group was internally evaluated.

Within the IEA research structure, there is no horizontal organization, which discusses practical level implications. This strict setup makes it difficult for the Working Group to directly extend to other TCPs, tie them together and foster in-depth knowledge exchange. Nevertheless, the Working Group has the ability to affect different TCPs through its participants (broad exchange between TCPs). Ultimately, there was a unanimous wish among the members that the Working Group should continue to exist in some form after the planned end date.

Thus, three different models of collaboration between technologies (TCPs) alone and between technologies (TCPs) and urban planners were discussed:

- A joint group of three TCPs (bi- or tri-lateral investigation)
- A joint annex
- A new TCP

After several discussions, it became clear that fulfilling the future objectives and answering the open research questions requires more resources and a formalized structure. Neither a follow-up Working Group nor a collaborative annex could cover all requirements. Following the discussions with the Enduse Working Party in 2019, the Working Group members conjointly decided to the DoCC TCP.

Based on the results of the 3rd meeting of the Working Group, the coordination group developed a draft for a strategic plan and a program of work, which also include a potential organizational model (with direct financial regulation effects). Discussions in the 4th meeting clarified the participating countries' interests in a new TCP. Furthermore, the meeting contributed additional definitions regarding the strategic plan's fundamental contents and determined the TCP's next steps.

The Strategic Plan (Annex II) and the Program of Work (Annex III) of the DoCC TCP were presented at the End-Use-Working-Party in March 2020. Based on the feedback of interested countries a Webmeeting with their CERT-members was held in December 2020. The final organizational model has to be clarified until the CERT-meeting in June 2021, the IEA's formal decision to launch this new DoCC TCP is planned for the fall-meeting of the Governing Board in 2021.

REFERENCES

- European Commission (2020a). Smart Cities and Communities. <u>https://ec.europa.eu/inea/en/horizon-2020/smart-cities-communities</u>
- European Commission (2020b). 100 Climate-neutral Cities by 2030 by and for the Citizens. https://ec.europa.eu/info/publications/100-climate-neutral-cities-2030-and-citizens en
- International Energy Agency (2016). Energy Technology Perspectives 2016 Towards Sustainable Urban Energy Systems. OECD/IEA.
- Jank, R. (2017). Annex 51: Case studies and guidelines for energy efficient communities. Energy and Buildings, 154, 529-537. doi:https://doi.org/10.1016/j.enbuild.2017.08.074
- Webster, J., Baier, C., Jank, R., Koch, A., & Shimoda, Y. (2013). Community Energy and Emissions Inventory and Modelling Tools to Support Local Energy Planning (LEP). In pro:21 GmbH & Projektträger Jülich (Eds.), Case Studies and Guidelines for Energy Efficient Communities - A Guidebook on Successful Urban Energy Planning. Stuttgart: Fraunhofer IRB Verlag.

FIGURES

Figure 1. Carbon emission reductions 2013-2050; (International Energy Agency, 2016)	3
Figure 2. Integrated planning process	11
Figure 3. Strategic measures for integrated planning (EBC Annex 63: Implementation of Strategies in Communities Volume 2: Development of strategic measures)	Energy
Figure 4. Five steps of the local energy transition process (EBC Annex 51: Jank, 2017)	17
Figure 5. Scope of WGCC Subgroups (Figure developed for the work plan by subgroup 3)	

TABLES

Table 1. Data, tools and methods for different scales (Webster et al., 2013)......18

ANNEXES

Annex I	Cities' needs (presentation and accompanying document
Annex II	DoCC TCP Strategic Plan
Annex III	DoCC TCP Program of Work