IEA HPP Annex 40

Heat pump concepts for Nearly Zero Energy Buildings

Project outline IEA HPP Annex 40

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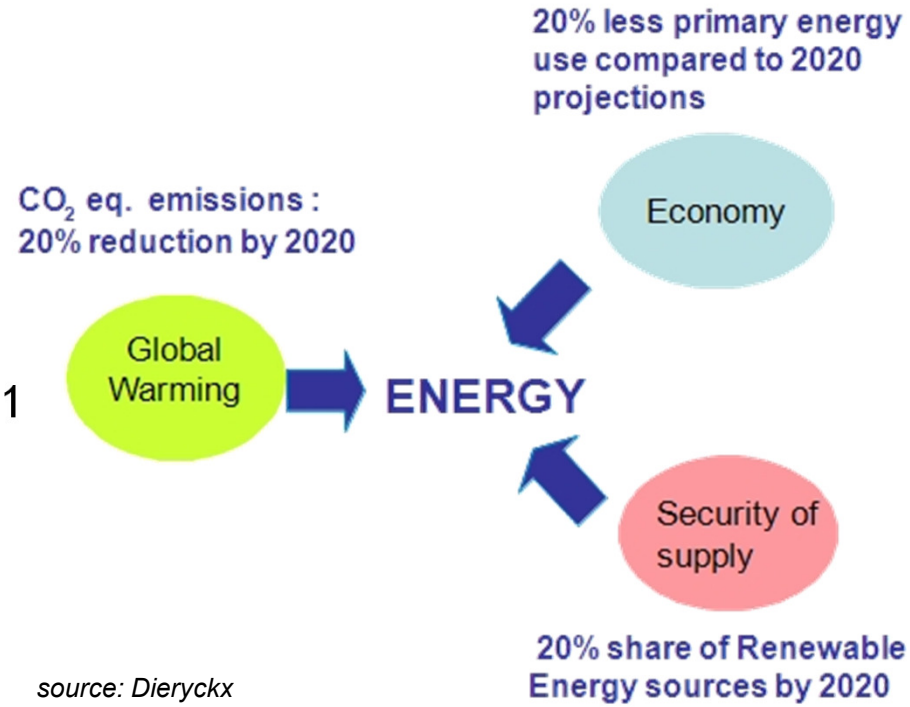
SHC Task definition workshop, Paris, March 2013

HSR
HOCHSCHULE FÜR TECHNIK
RAPPERSWIL
FHO Fachhochschule Ostschweiz

Framework – Political targets and strategies

- **EU strategy: 20-20-20 until 2020**
- **20% renewable energy shares**
  - Heat pump source is considered renewable
- **20% Energy Efficiency (=> EPBD recast)**
  - New buildings shall reach nearly zero by 2021
- **20% reduced CO_2-emissions**
  - Heat pumps in Nearly Zero Buildings are an economical way to cut CO_2 emissions



source: Dieryckx

- **USA (DOE) /Canada**
  - All new residential (commercial) buildings shall be Net Zero energy buildings (NZEB) by 2020 (2025) => “maximum efficiency houses”, also retrofit in focus
  - All buildings shall be Net Zero by 2050
- **Japan**
  - Heat pumps and high performance buildings are considered as key technologies to mitigate climate change

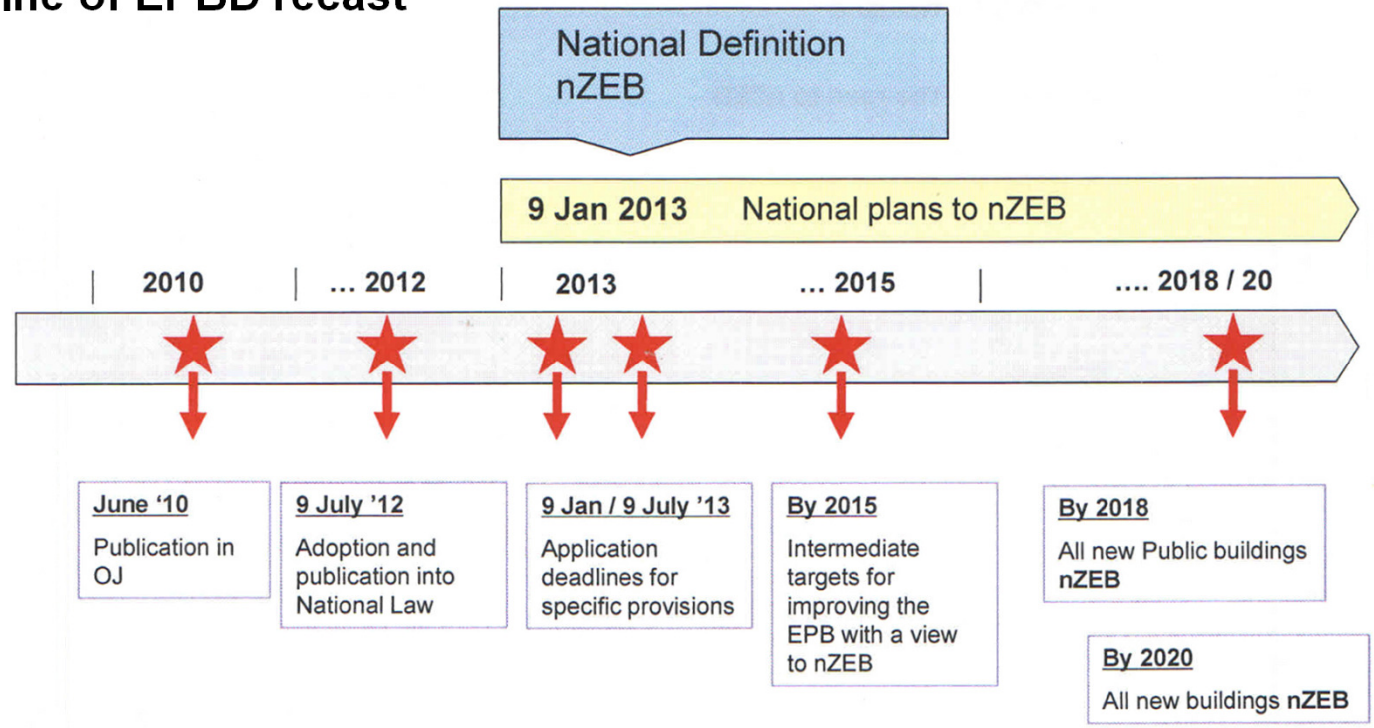
nZEB Definition

EPBD DEFINITION "Nearly Zero Energy Building (nZEB)"

- Means a building that has a very high energy performance
- ***Nearly zero or very low energy amount*** should be covered to ***very significant extent*** by energy from renewable sources, including renewable energy ***produced on-site or nearby***

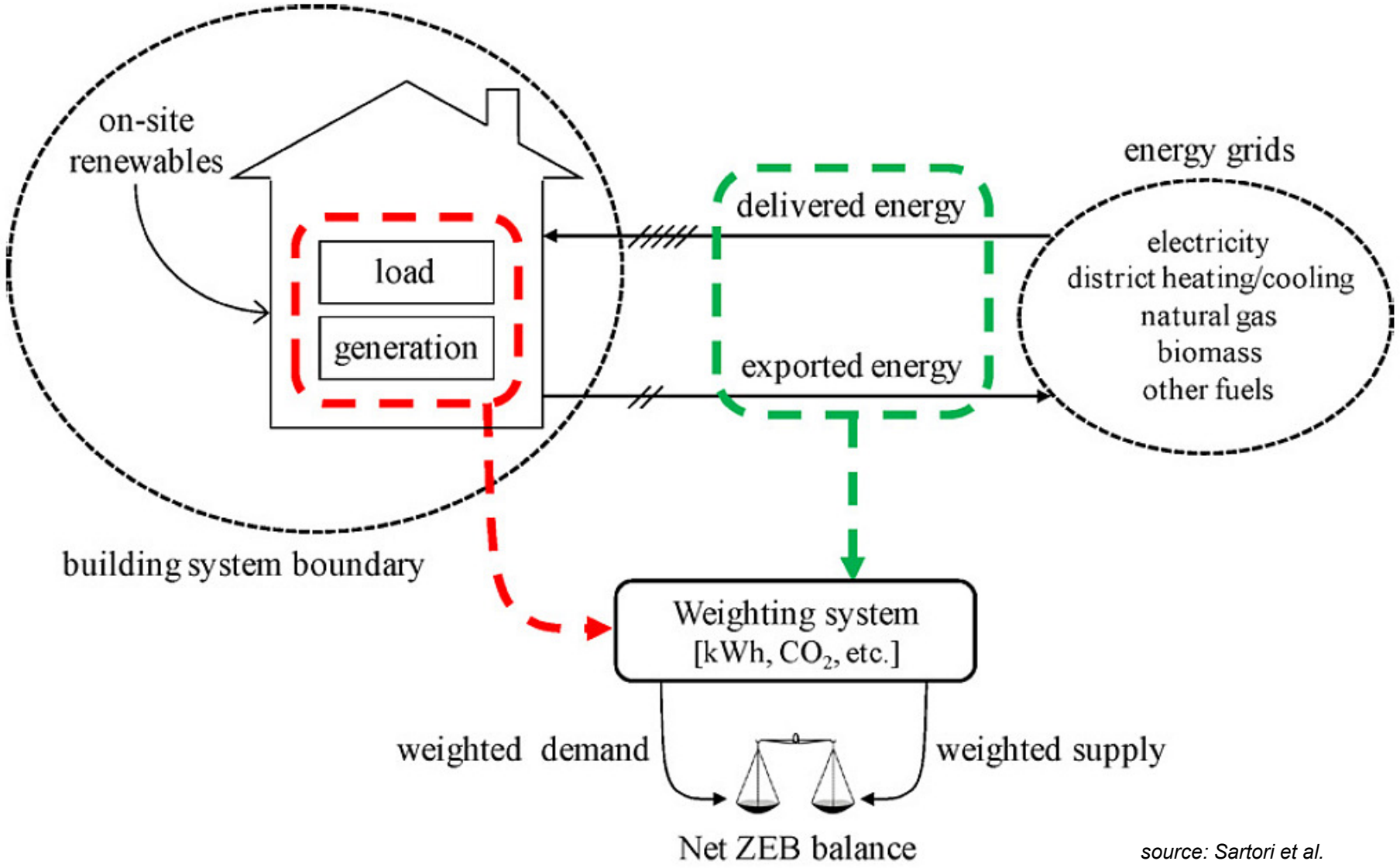
=> Presently no common definition of nZEB, neither in policy nor in the market

- **Timeline of EPBD recast**



source: DAIKIN Europe

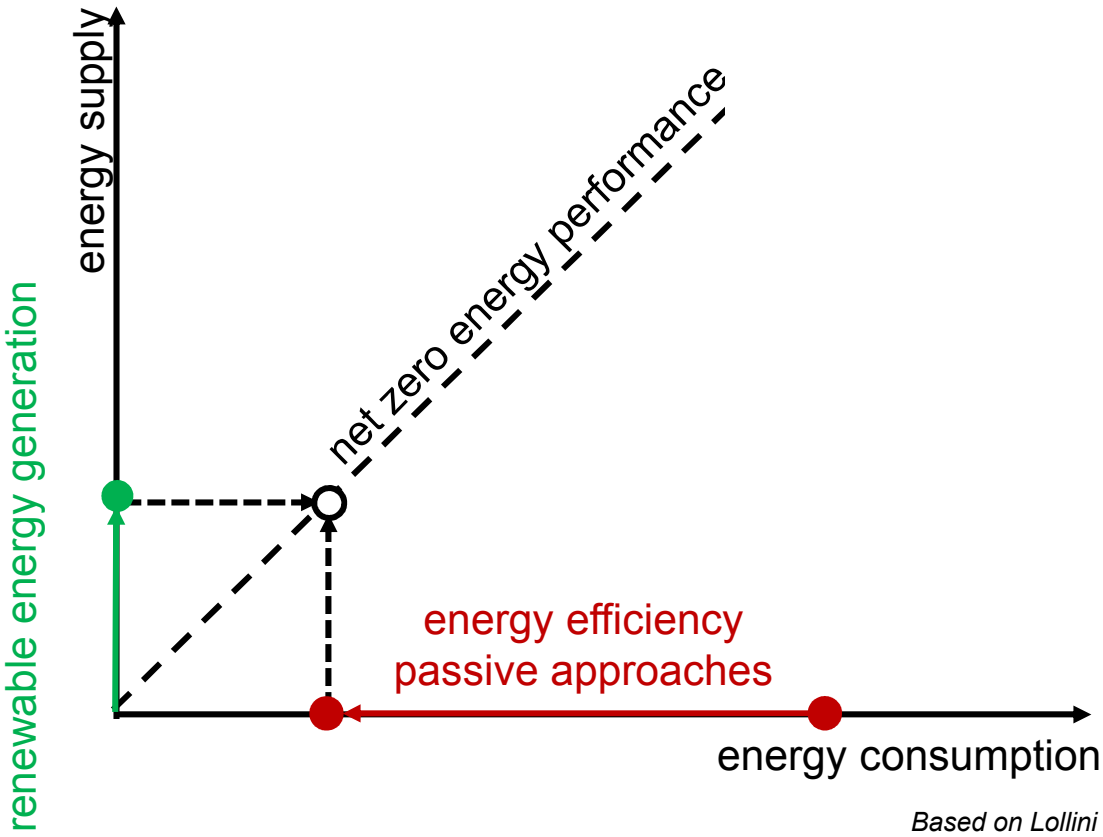
NZEB Definition



source: Sartori et al.

NZEB Definition

- **Principle of Nearly Zero Energy Buildings (NZEBs)**



Based on Lollini

Framework for consistent definition

- Building system boundary
  Physical boundary ("on-site")
  Balance boundary ("type of energy")
- Weighting system
  Metrics ("Primary energy, CO_2")
  Symmetric weighting
  Time dependent weighting
- Net ZEB Balance
  Balancing period ("annual or shorter")
  Type of balance (e.g."import/export")
  Energy efficiency requirements
  Energy supply requirements
- Temporal energy match characteristic
  Load mismatch (e.g. summer surplus)
  Grid interaction
- Measurement and verification

IEA HPP Annex 40 – Objectives and Scope

- **Open questions**
  - How is an NZEB reached most energy- and cost-effectively?
  - How should heat pumps be integrated?

?

- **Objectives**

1. Optimisation of heat pump concepts for NZEB

2. Evaluation of system integration options for NZEB

3. Requirements for further developments to exploit specific performance opportunities (e.g. multi-source ability, capacity control, temperature lift)

- **Scope**
  - Residential buildings (focus on space heating, DHW)
  - small commercial buildings (focus on space heating/cooling, ventilation)

IEA HPP Annex 40 – Task 1: State-of-the-art analysis

- **Task 1: State-of-the-art technology and concepts**
  - Classification of available envelope and system technology as well as concepts for NZEB
  - Definition of an NZEB for the IEA HPP Annex 40

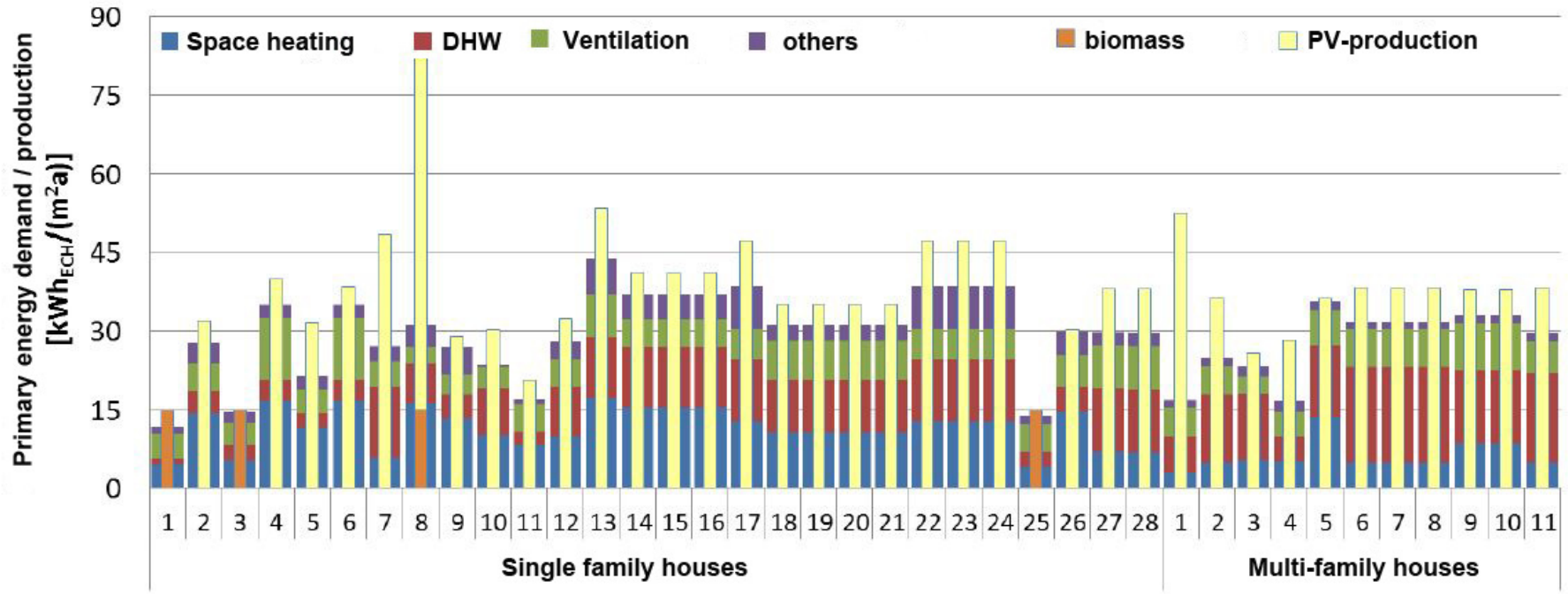
- **Steps:**
  - Survey/evaluation of existing technology and concepts
  - Check of suitability for new buildings and retrofit
  - Summary of most promising state-of-the-art concepts/technologies
  - Missing components and development options for NZEB

- **Deliverables (as country reports)**
  - Categorisation of concepts for NZEBs
  - Technology matrix of suitable building and system components

Evaluation Swiss MINERGIE-A® Label - residential

MINERGIE-A®

- **MINERGIE-A® is a common approach for NZEB in Switzerland**
- **Evaluation of 39 certified residential MINERGIE-A® houses**
- **Average weighted demand is about 29 kWh/(m²a) to be compensated with PV-production**
- **Average installed peak power of the solar PV system is 5.5 ± 3 kW_p**
- **80% of the buildings use heat pumps, only few use biomass, some solar DHW**

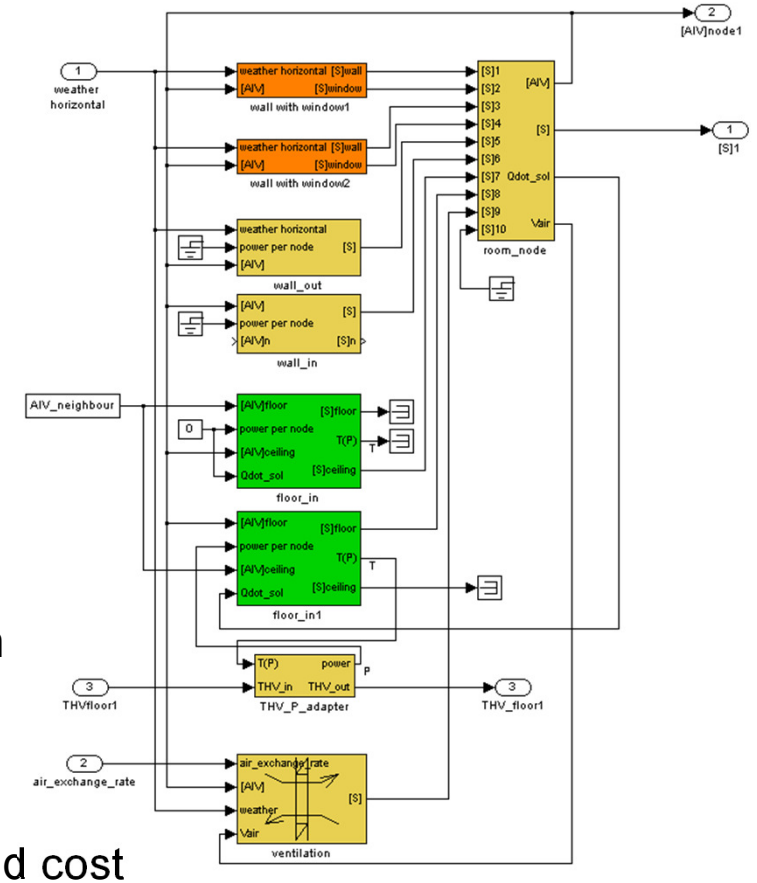


source: Hall

- **Task 2: Assessment of concepts**
  - Assessment of
    - technology options
  - regarding the performance and cost

- **Steps**
  - Comparison of technologies and concepts
  - Improvement of concepts by calculation/simulation
  - Design and performance evaluation
  - Control of systems
  - Recommendation on system configuration and operation

- **Deliverables**
  - Adapted technology for NZEB regarding performance and cost
  - Improved building technology and integration

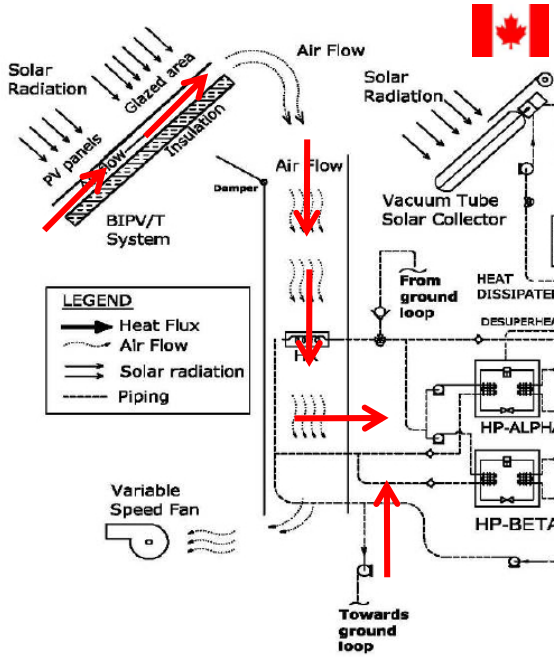


IEA HPP Annex 40 – Task 3: Technology development and field trial

- **Task 3: Technology development and field monitoring**
  - Requirements for technology development
    - of heat pumps including the source and sink systems
  - Investigation of prototype systems in lab- and field testing

source: IVT

- **Approaches**
  - Building integration of renewable energies
  - Multi-source heat pumps
  - Advanced controls, capacity control
  - Efficient DHW solutions
  - Refrigerants

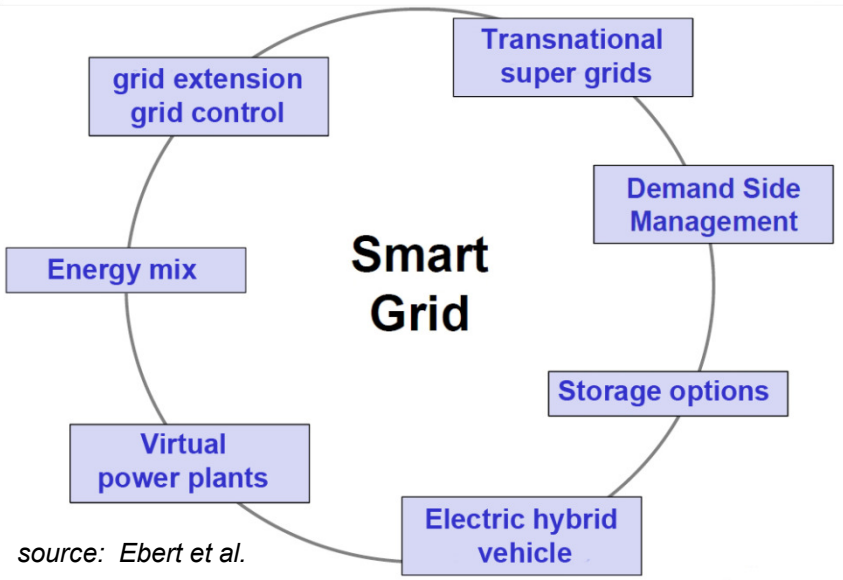


source: Pogharian, Candanedo, Athienitis

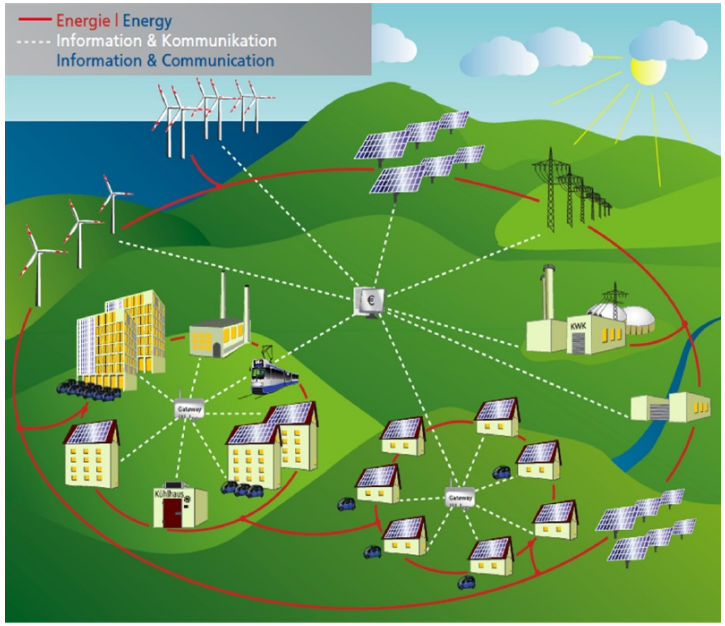
- **Deliverables (as country reports)**
  - Adapted components and systems as prototypes
  - System concepts approved by field-monitoring

IEA HPP Annex 40 – Task 4: Specific questions for broad integration

- **Task 4: Broad introduction of NZEB: Integration of buildings into the energy system**
  - Load mismatch
  - Grid interaction
  - Needs for storage, e.g.
    - Electrical or thermal storage systems
    - Heat pump to store electrical surplus as heating/cooling energy
- **Approaches**
  - How can self-consumption be optimised?
    - Potentials of “smart” (ICT)-technologies
    - Load/generation management
    - Storage integration
  - Is a definition for a single building useful?
    - “Clusters of buildings”
    - “Smart cities”



source: Ebert et al.



IEA HPP Annex 40 – Deliverables

- **Scope**
  - Concepts and technologies for NZEB with heat pumps
  - Residential and small commercial buildings
  - All buildings services as needed
- **Deliverables**
  - Technical recommendations, methods and tools for concepts and design
  - Test results of prototype technologies
  - System assessment by simulations
  - Simulations models
  - Field experience of systems in NZEB
  - Best practice systems
  - Accompanying technical reports
- **Project time**
  - July 2012 – June 2015

IEA HPP Annex 40 – Participating and interested countries

- **Participating countries (state March 2013)**


CA: CanmetENERGY, Natural Ressources, Hydro-Quebec


CH: Univ. Appl. Sc. Rapperswil, Univ. Appl. Sc. Northwestern Switzerland


JP: Uni Nagoya, Japanese manufacturers


NL: SEV


NO: SINTEF Energy Research, COWI, Enova SF


SE: SP, SVEP


US: ORNL, NIST, University of Maryland

- **Interested countries**


BE: Daikin Europe NV, Uni Liège, Th!nk E

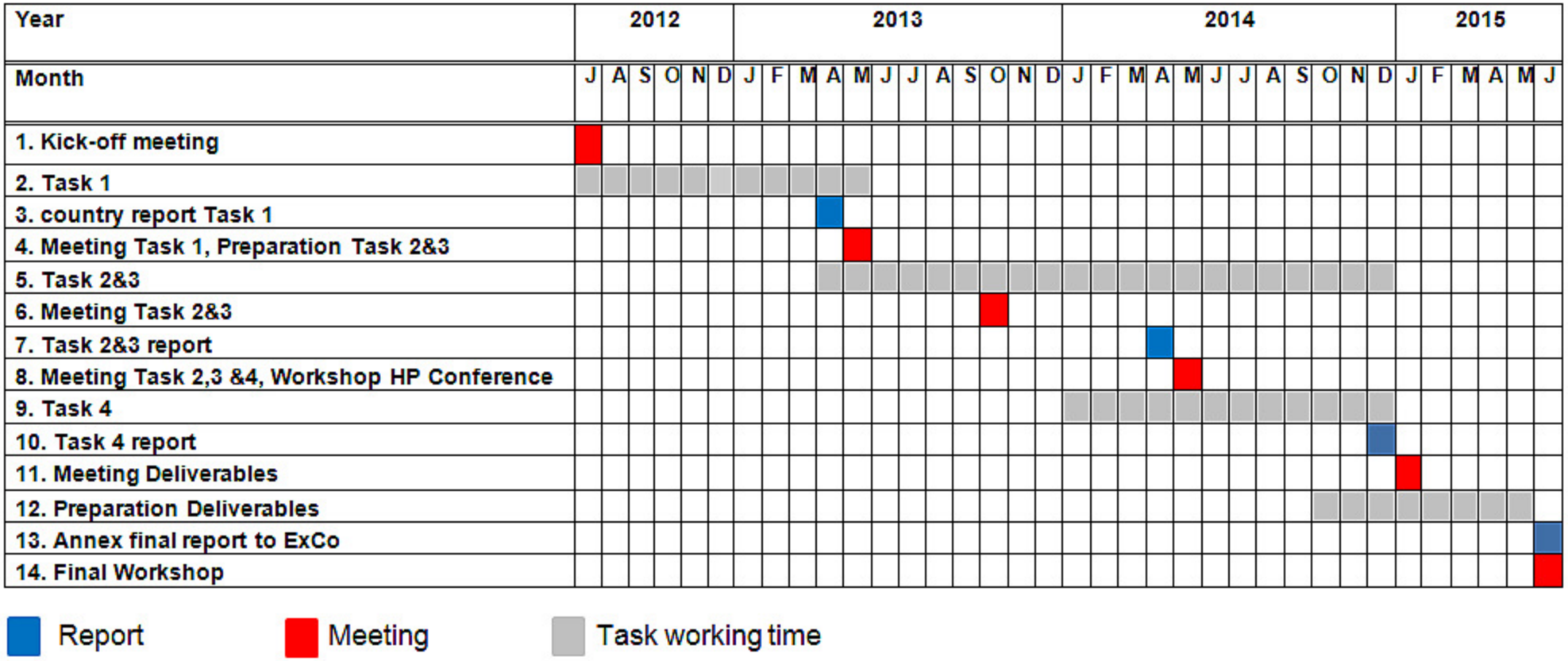

DE: Viessmann GmbH, Uni Nürnberg, HLK Stuttgart GmbH, Fraunhofer ISE


FI: Aalto University, VTT, SULPU


KR: Korean Institute of Energy Research (KIER)

IEA HPP Annex 40 – Time schedule

- **Time schedule of the Annex based on Kick-off meeting**



Links between the projects

- **Common items**
  - NZEB could be an application case for solar cooling & heating
  - Load match evaluation and load management
  - Simulation work
  - Developments for heat pump and chiller
  - Integration options of heat pump/chiller with PV and solar thermal
  - Storage integration

- **Conclusion**
  - Projects have synergies
  - Projects also complementary (focus cooling, countries involved, systems etc.)
  - Collaboration useful

Thank you for your attention!

Kick-off meeting IEA HPP Annex 40 in July 2012 at HSR Rapperswil, Switzerland