Aalto University
School of Science

Uusinta energiateknologiaa
New Energy Technologies

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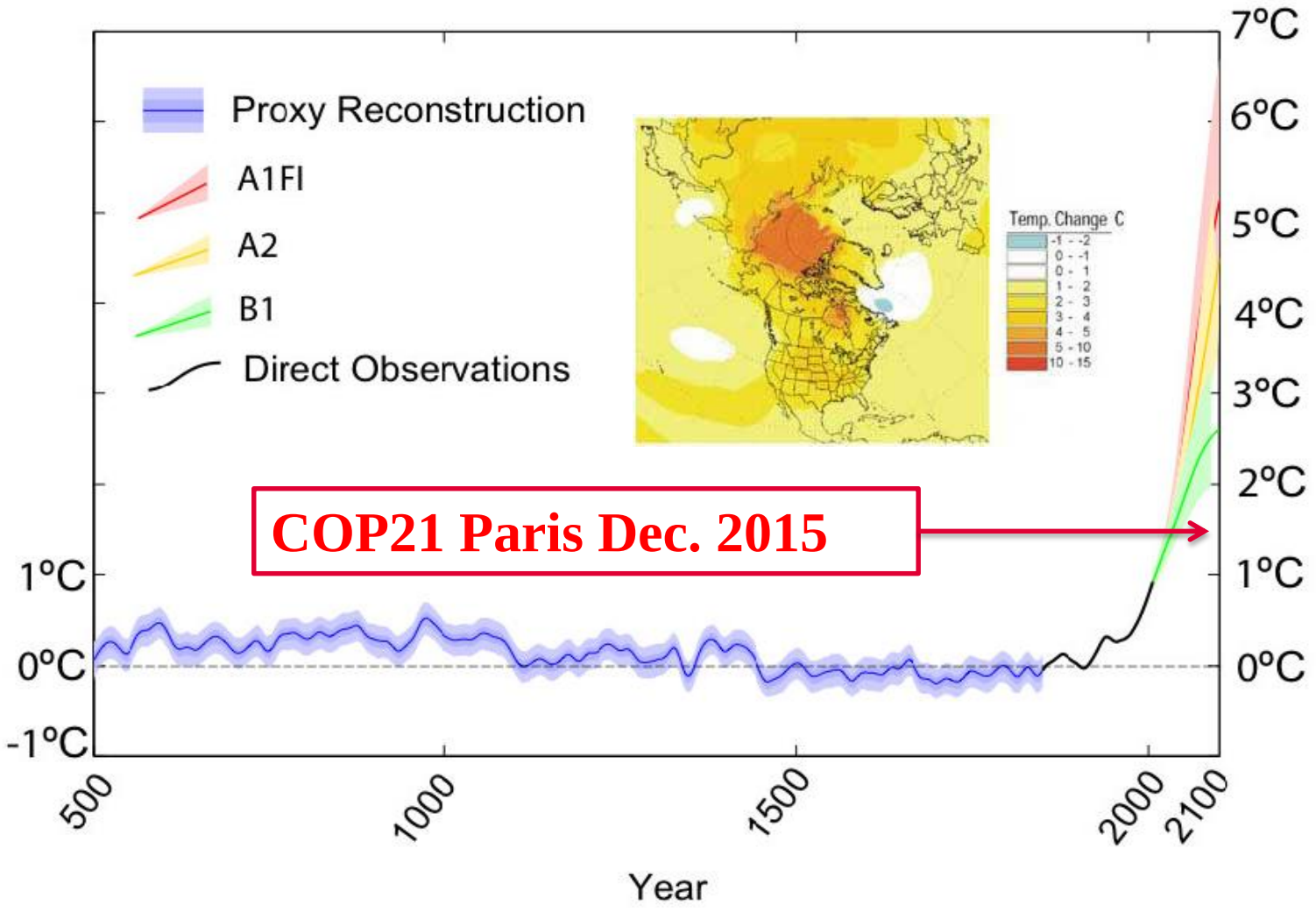
Outline of the presentation

Drivers
Innovations
Systems

Global Temperature Relative to 1800-1900 (°C)



Energy-Climate Nexus

CO_2 sources = CO_2 sinks > 2050

Negative CO_2 emissions >2050 ???

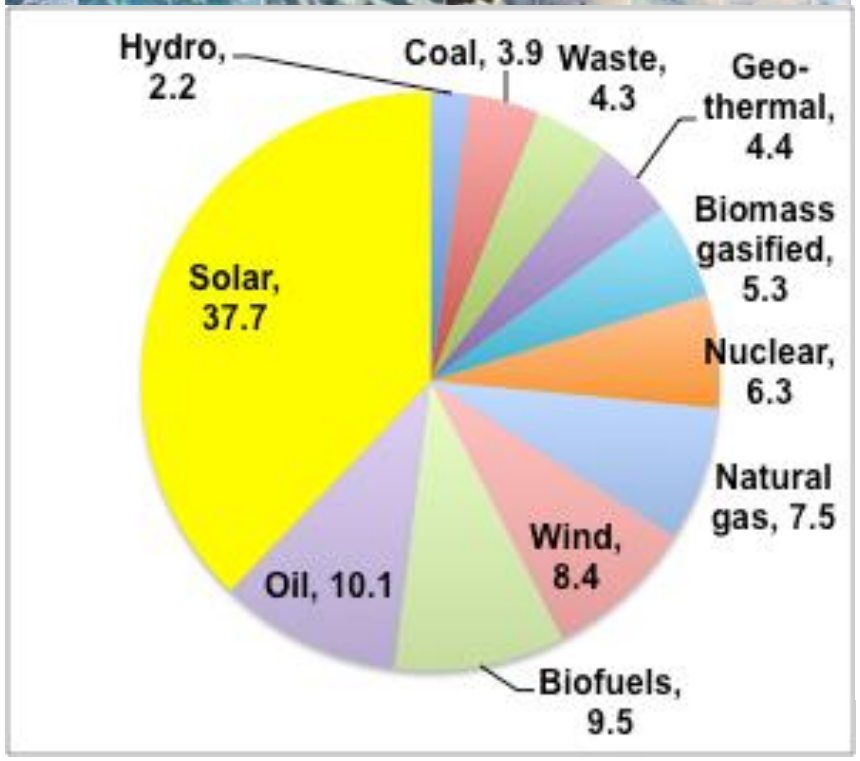
Fossil fuels now >80% of global energy

Coal (power) & oil (traffic) ≈ 80% of CO_2

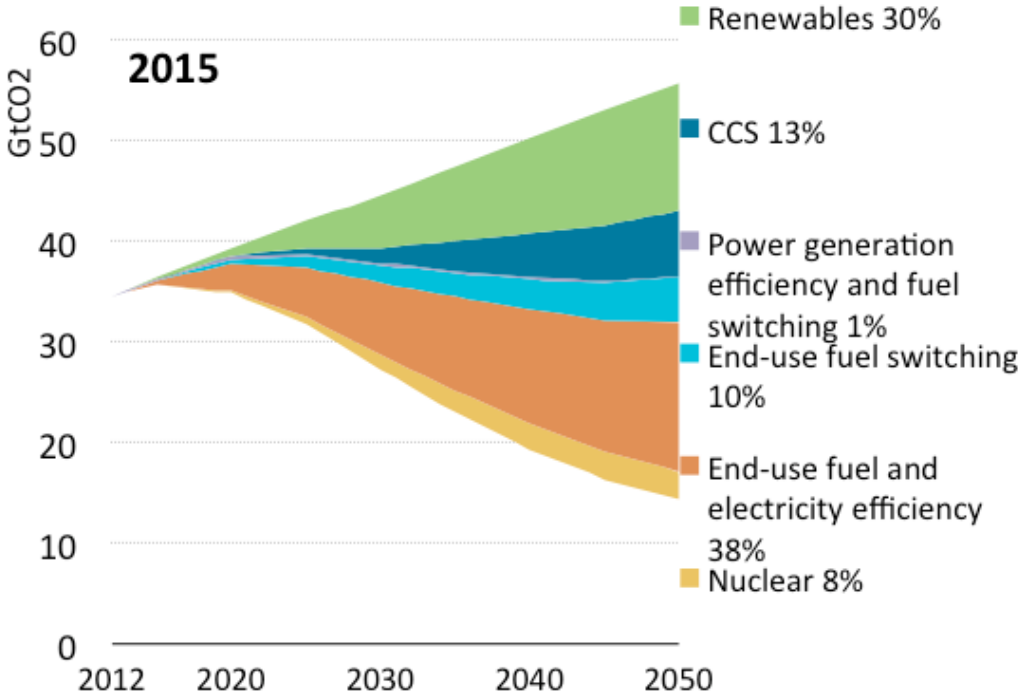
Forthcoming energy transition

- **Fossil fuels of energy: Today >80%; 22% by 2100**

http://www.shell.com/global/future-energy/scenarios/new-lens-scenarios.html



IEA transition scenario



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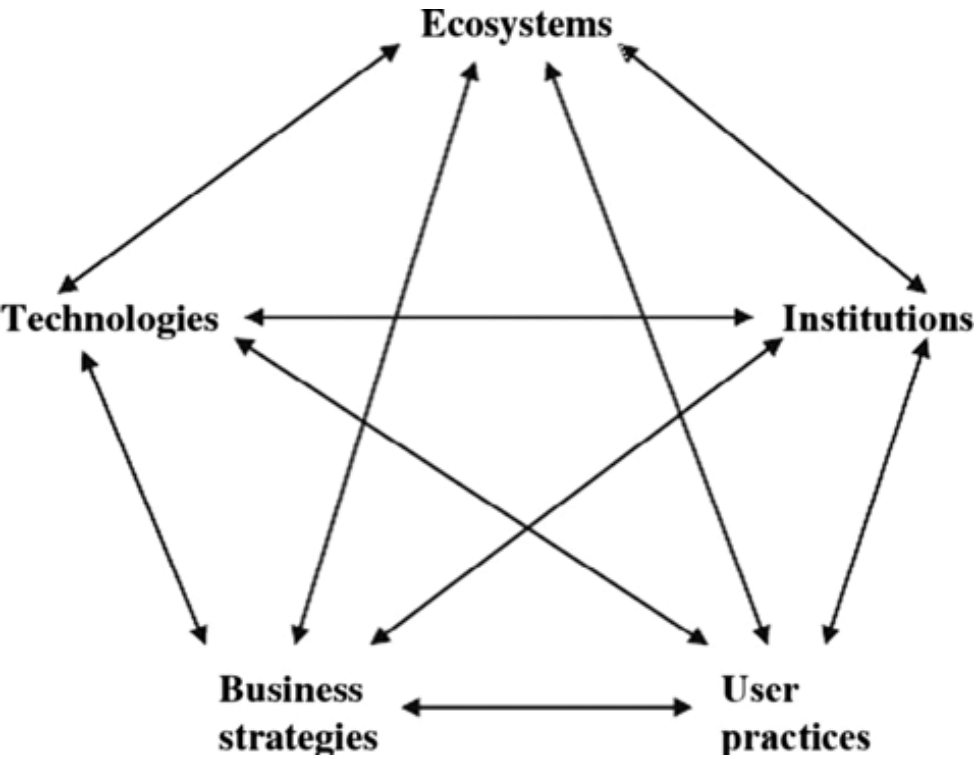
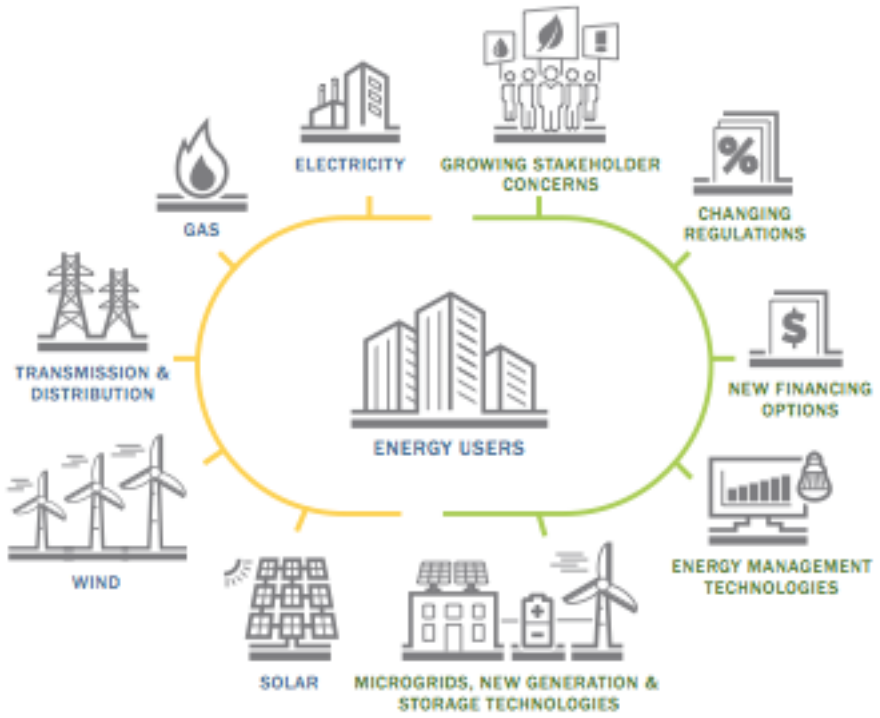
Framework for energy transition

- ***Technologies*** – e.g. energy conversion, supply and end-use technologies.
- ***Institutions*** – e.g. social rule systems relating to policy, planning, risk, investment.
- ***Business strategies*** – e.g. different business models, such as energy utility or energy service company (ESCo) models.
- ***User practices*** – e.g. social practices relating to heating, cooking, cleaning and appliance use.
- ***Ecosystems*** – e.g. impacts on local air quality, noise and land use, and global carbon emissions.

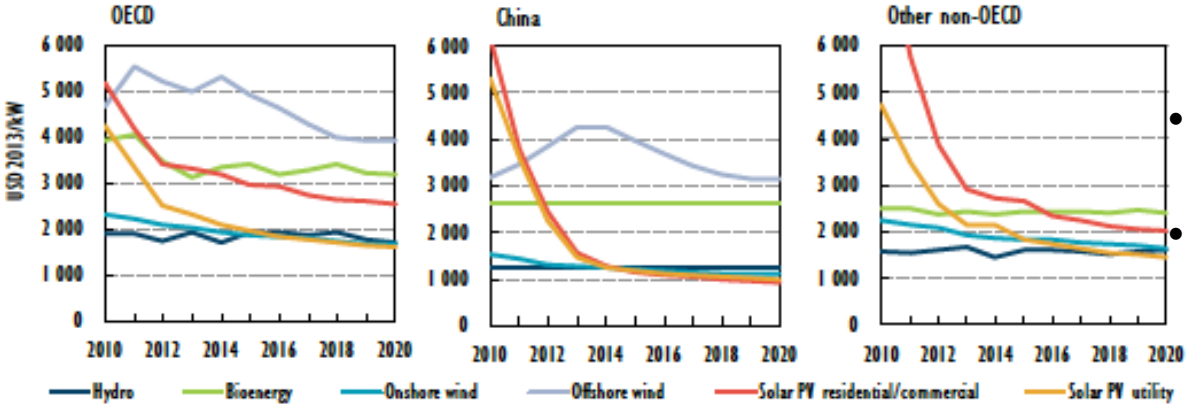




Applied Energy 138 (2015) 150–159

Progress in new energy

Figure 5 Weighted average annual renewable investment costs, historical and projected

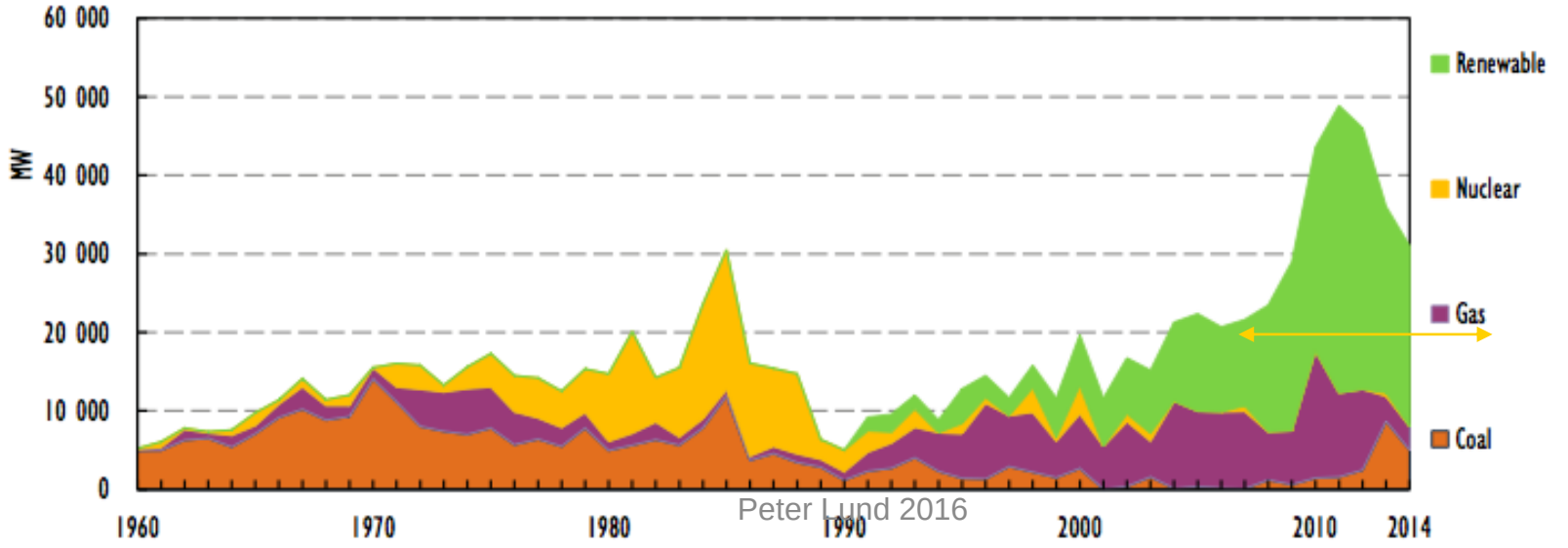


Note: kW = kilowatt. Average unit investment costs are based on gross additions, which include capacity refurbishments that are typically lower cost than new capacity. Costs vary over time due to technology changes as well as where deployment occurs in a given year.

- **PV modules (2015) $.53 W_p^{-1}; 0.3W_p^{-1}$ (2017);**
- **PV systems (2015) $1.65 W_p^{-1} ; $1 W_p^{-1} (<2020) → full global cost-parity**

(Source:IEA,2015)

Figure 1.3 • Capacity addition in OECD Europe by technology, 1960-2014

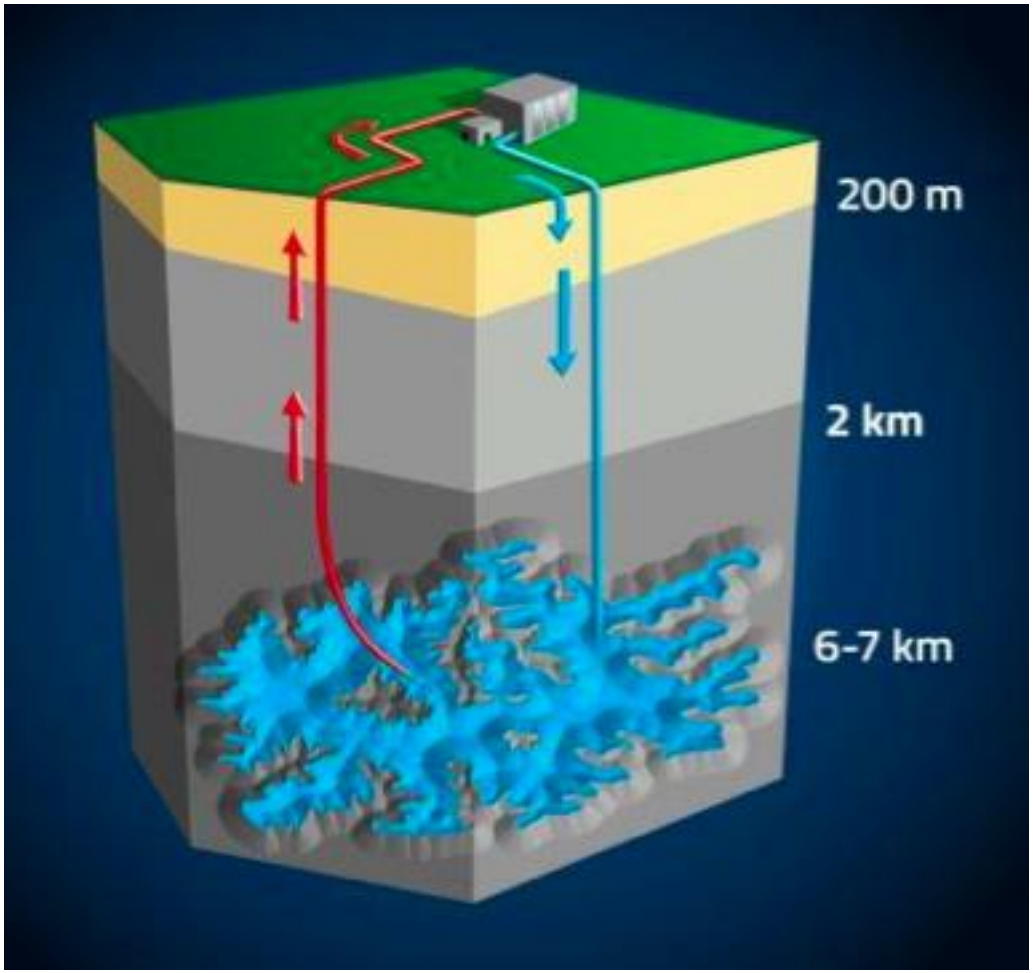


Urban environment important for energy

- ½ of all people live in cities (70% by 2040)
- 2/3 of energy consumed in cities (80% by 2040)
- Final energy use: thermal energy 50% (heat); electricity 20-30%; transport 25-30%
- Urban energy solutions: on-site energy generation, urban renewables, waste utilization, prosumers, etc.

UNEP, 2010

Example of urban sustainable heat: Otaniemi Deap Heat



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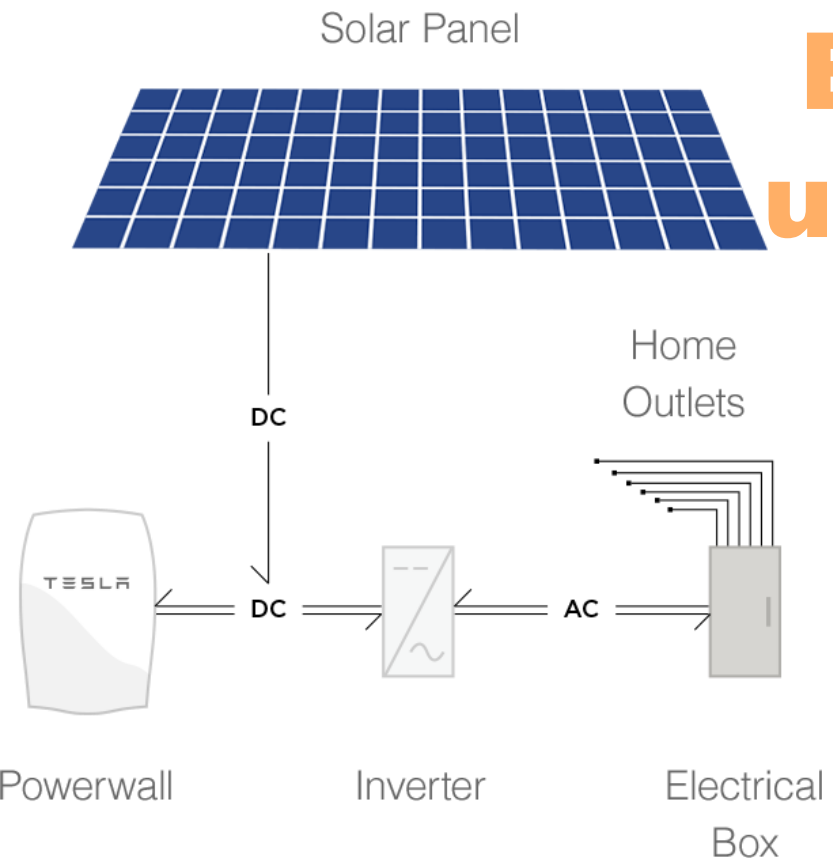
Example of single urban technologies [PV-EV]

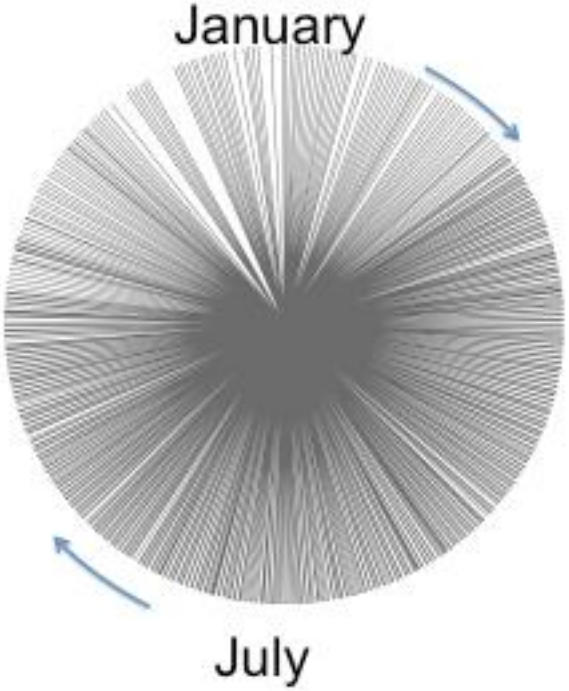


Combining PV & Tesla Battery

Case: a typical Finnish household, PV(year)=Demand(year)

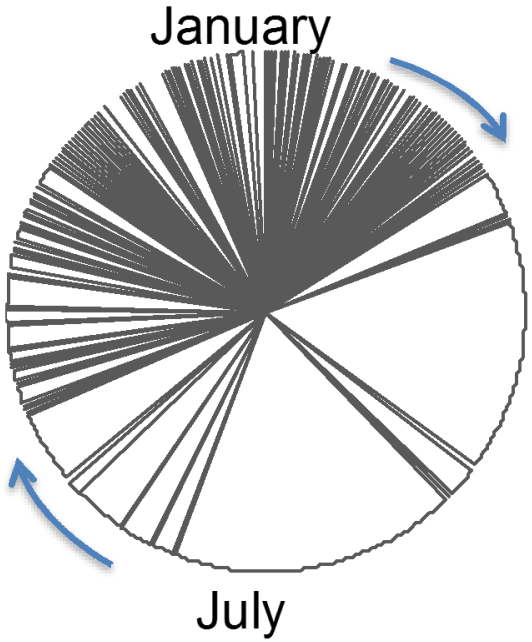
Hours when solar doesn't meet demand (black):

PV no battery



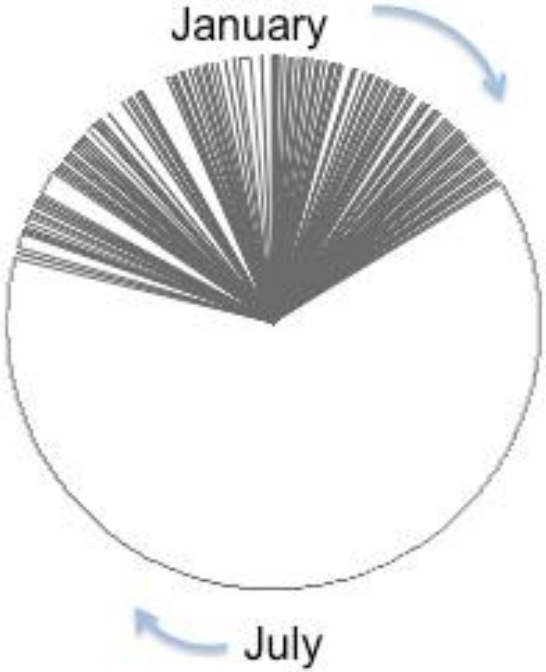
32%

PV + 1 Tesla battery



74%

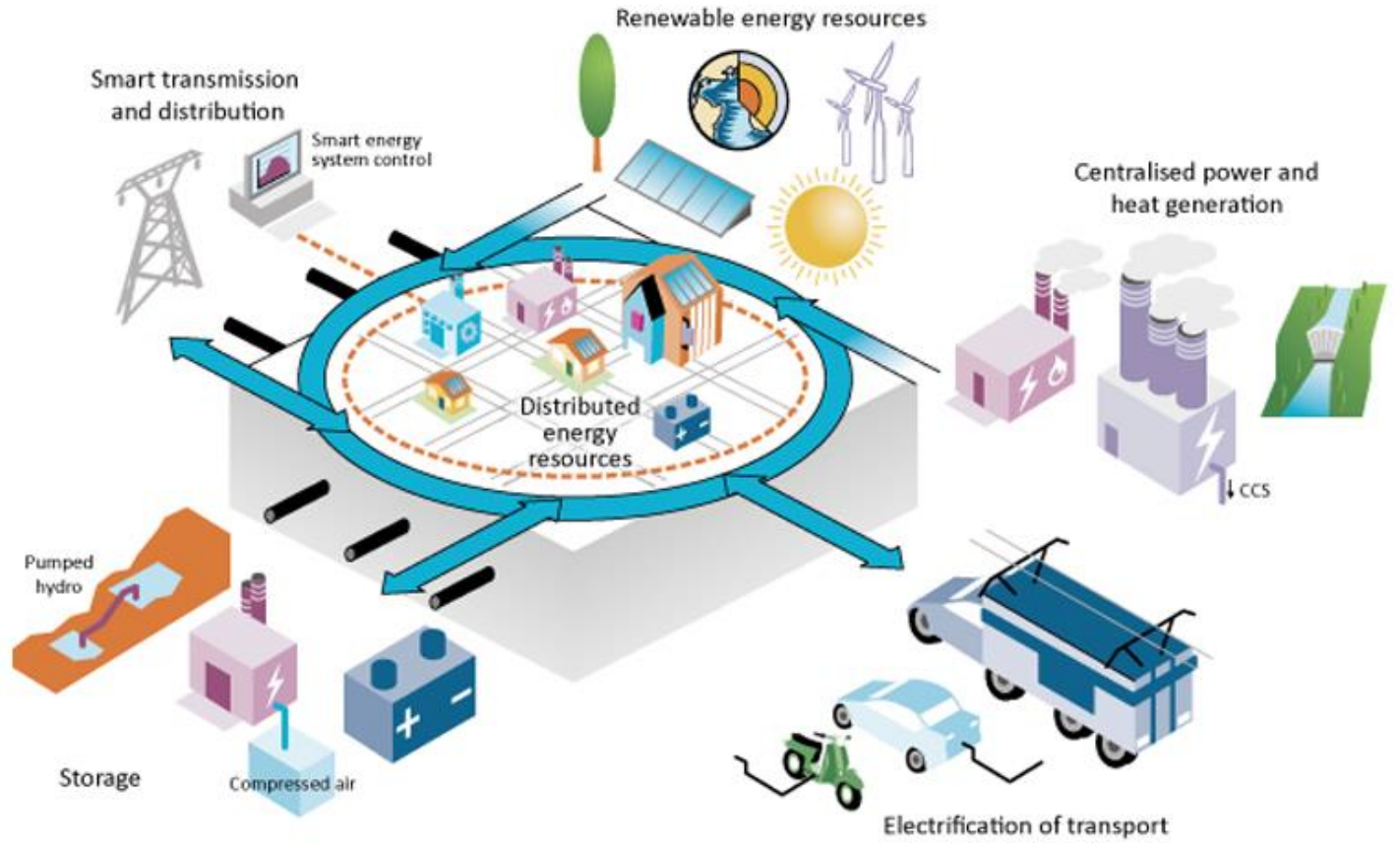
PV + 2 Tesla batteries



76%

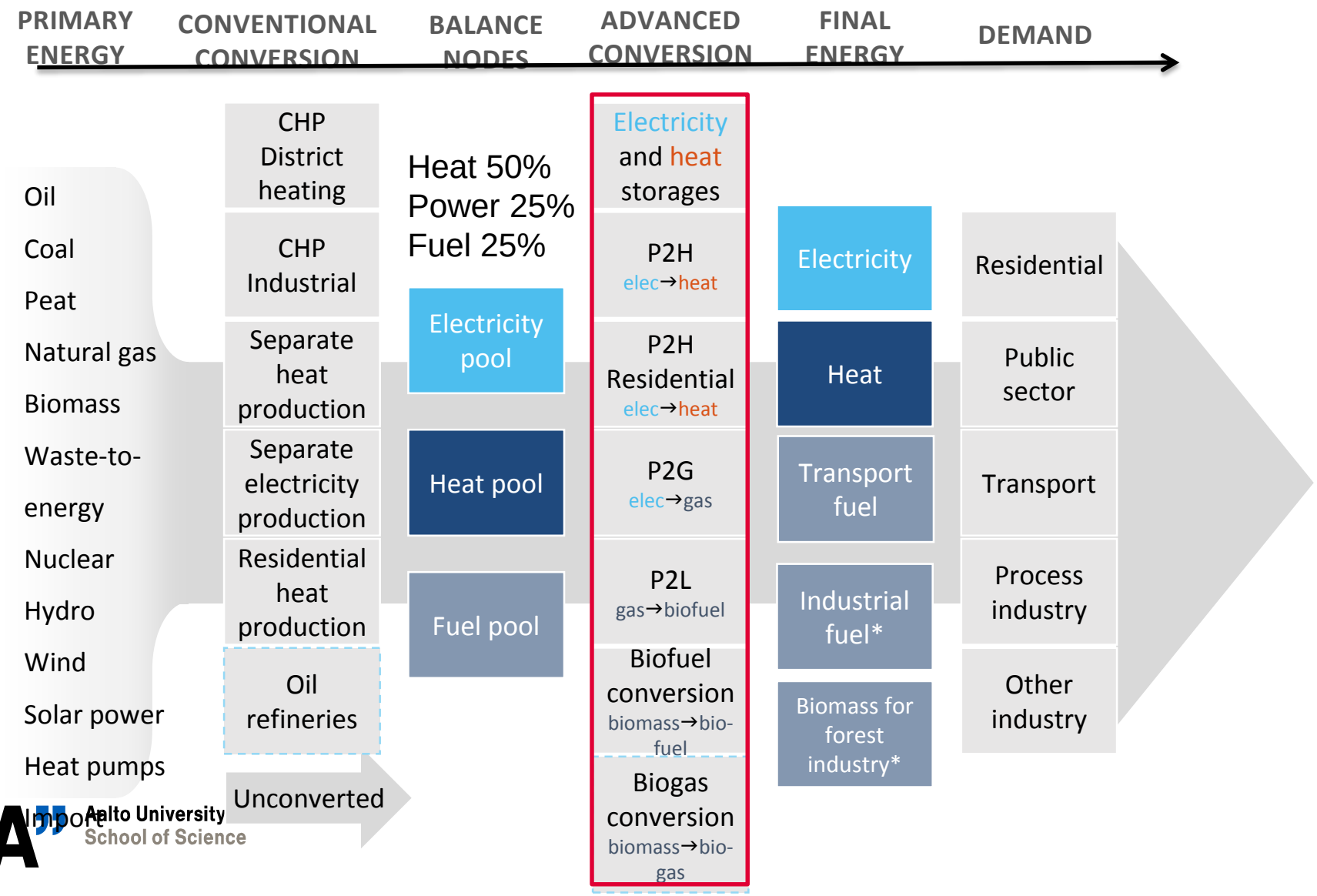
Self-use of PV (yearly output =100% of demand)

Built environment & smart infrastructures & system integration for 'new energy'



International Energy Agency (2014), Energy Technology Perspectives 2014, OECD/IEA, Paris

Power-to-X (P2X) linked to final energy



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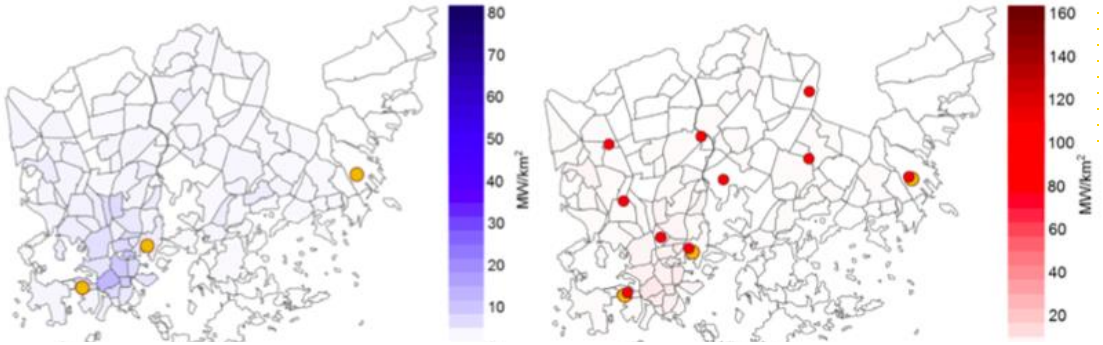
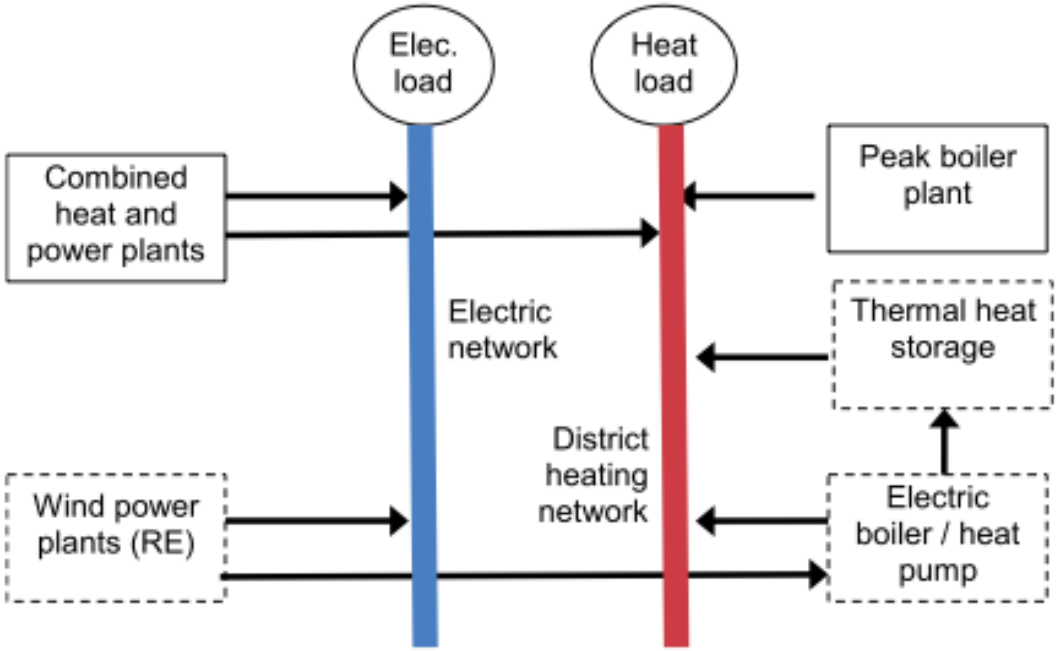
Application of big VRE*) & P2X to urban-scale



Power and heat demand & power plants in Helsinki

$1GW_{el}$;$1.3GW_{th,CHP}$; $2.0GW_{th,peak}$ (coal, gas)



*) VRE= variable renewables, e.g. solar & wind

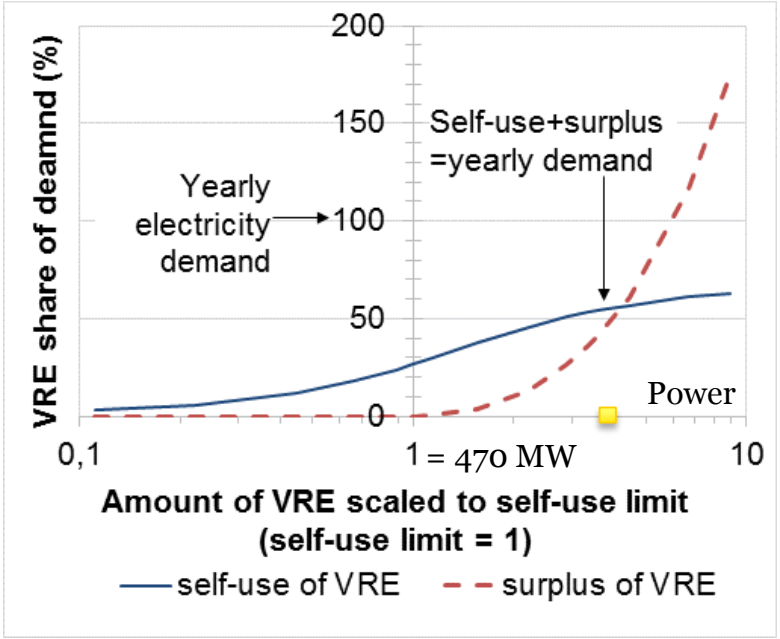
Fig. 4. Schematic of the energy system configuration in Helsinki (Finland). Dashed line boxes are energy system components for the wind power scheme with surplus electricity-to-therm

P.D. Lund et al. / Journal of Cleaner Production 103 (2015) 437–445

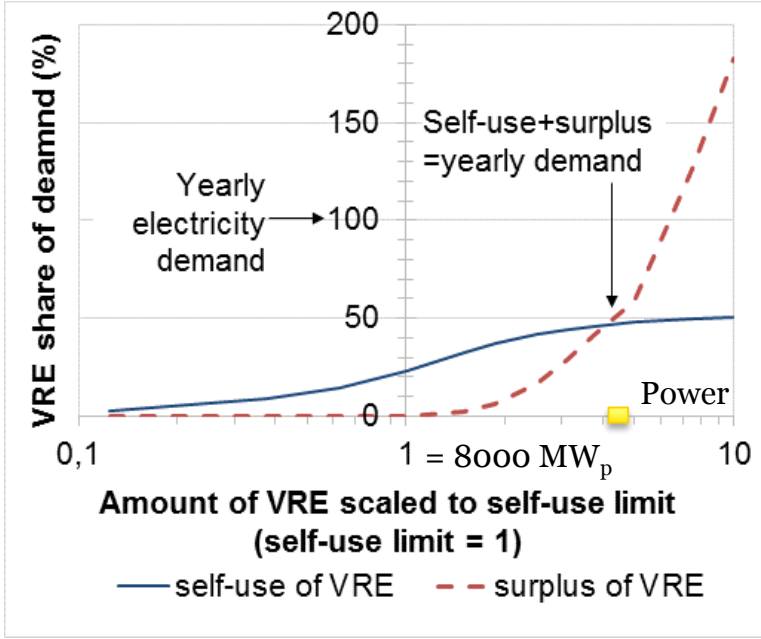
How much VRE can urban energy systems 'absorb'?

- Self-use limit (SUL) of VRE typically around 20-30% of yearly demand
- Going beyond SUL increases VRE share of demand, but saturates if SUL>3

Helsinki & Wind

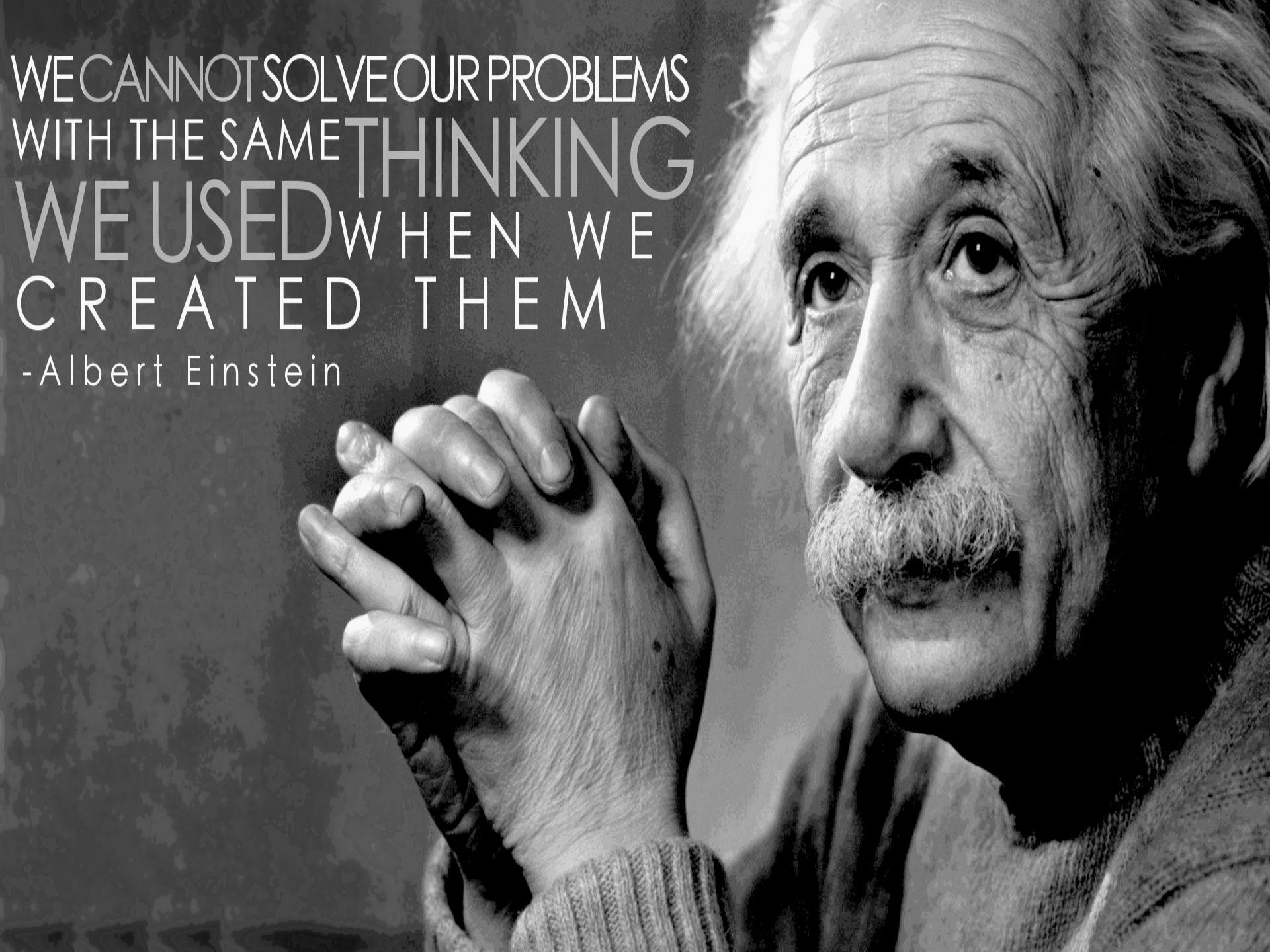


Delhi & PV



CONCLUDING REMARKS

- **Huge efforts required in clean energy to limit the global temperature rise to 1.5 °C;**
- **New energy technologies will play a key role in the upcoming energy transition**
- **Built environment, systems, and integration are key areas for sustainable energy**
- **Electricity may need to be employed in other final energy sectors (through advanced conversion P2X)**


WE CANNOT SOLVE OUR PROBLEMS
WITH THE SAME THINKING
WE USED WHEN WE
CREATED THEM
-Albert Einstein