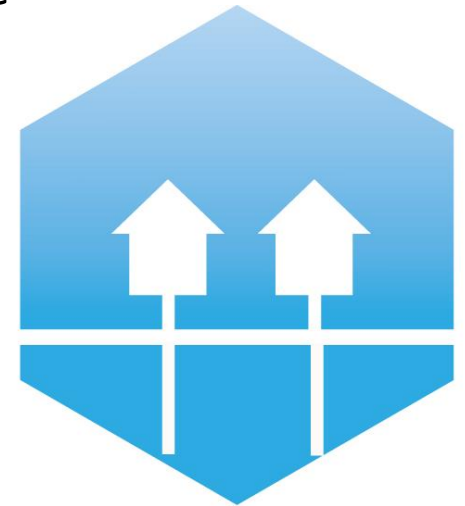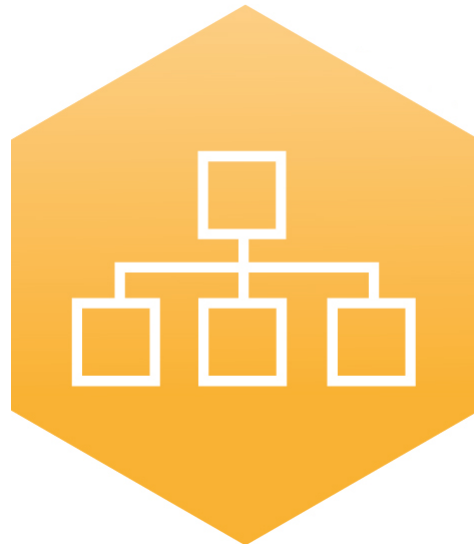# Production of future district heating and cooling – applying TIMES models on six European countries

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4DH
4th Generation District Heating
Technologies and Systems

Agenda

- **ProgRESsHEAT project**

- **Geographical Scope**

- **TIMES Models**

- **Data Sources**

- **Model Test Run**

- **Further Developments**

"Supporting the progress of renewable energies for heating and cooling in the EU on a local level"
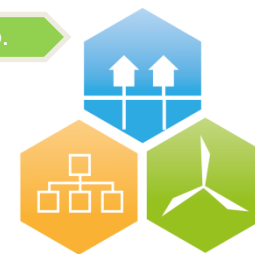
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4th Generation District Heating
Technologies and Systems

Objective: to assess renewable <u>energy policies</u> at **EU**, **national**, **regional** and **local** levels using **energy models** in a coordinated and integrated manner using best practice examples with significant replication potential.

Time Horizon: from 2012 to 2020/2030/2050

DTU

Fraunhofer ISI

Energy Economics Group

inegi
Instituto de Engenharia
Mecânica e Gestão Industrial

IREES
Institute for Resource Efficiency
and Energy Strategies

energycities
WHERE ACTION & VISION MEET

A3MEE
Asociatia "Agentia pentru Managementul
Energiei si Protectia Mediului" Brasov

ee energy engineers

LITOMĚŘICE
ZDRAVÉ MĚSTO

OÖENERGIESPARVERBAND

GATE 21

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Funded by the Horizon 2020 Programme of the European Union

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Geographical Scope

- **6 Countries:** Denmark, Germany, Czech Republic, Austria, Portugal and Romania
- **3 Geographical levels:** National, regional and municipal

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TIMES

The Integrated MARKAL-EFOM System - TIMES was developed and is maintained by the Energy Technology Systems Analysis Programme (**ETSAP** – est. in **1976)** within **IEA**.
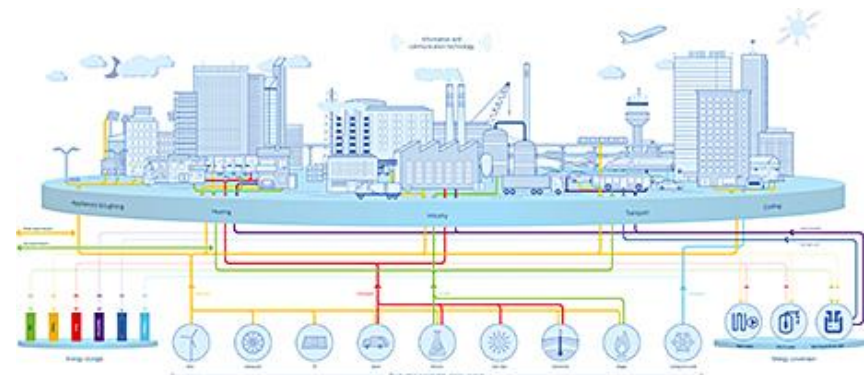
Characteristics: Linear equilibrium optimization model

- Technology-rich, bottom-up model generator covering the "4E" aspects of energy systems – *energy*, *economy*, *environment* and *engineering*.

- Assumptions: perfectly competitive markets, full foresight / myopic foresight.
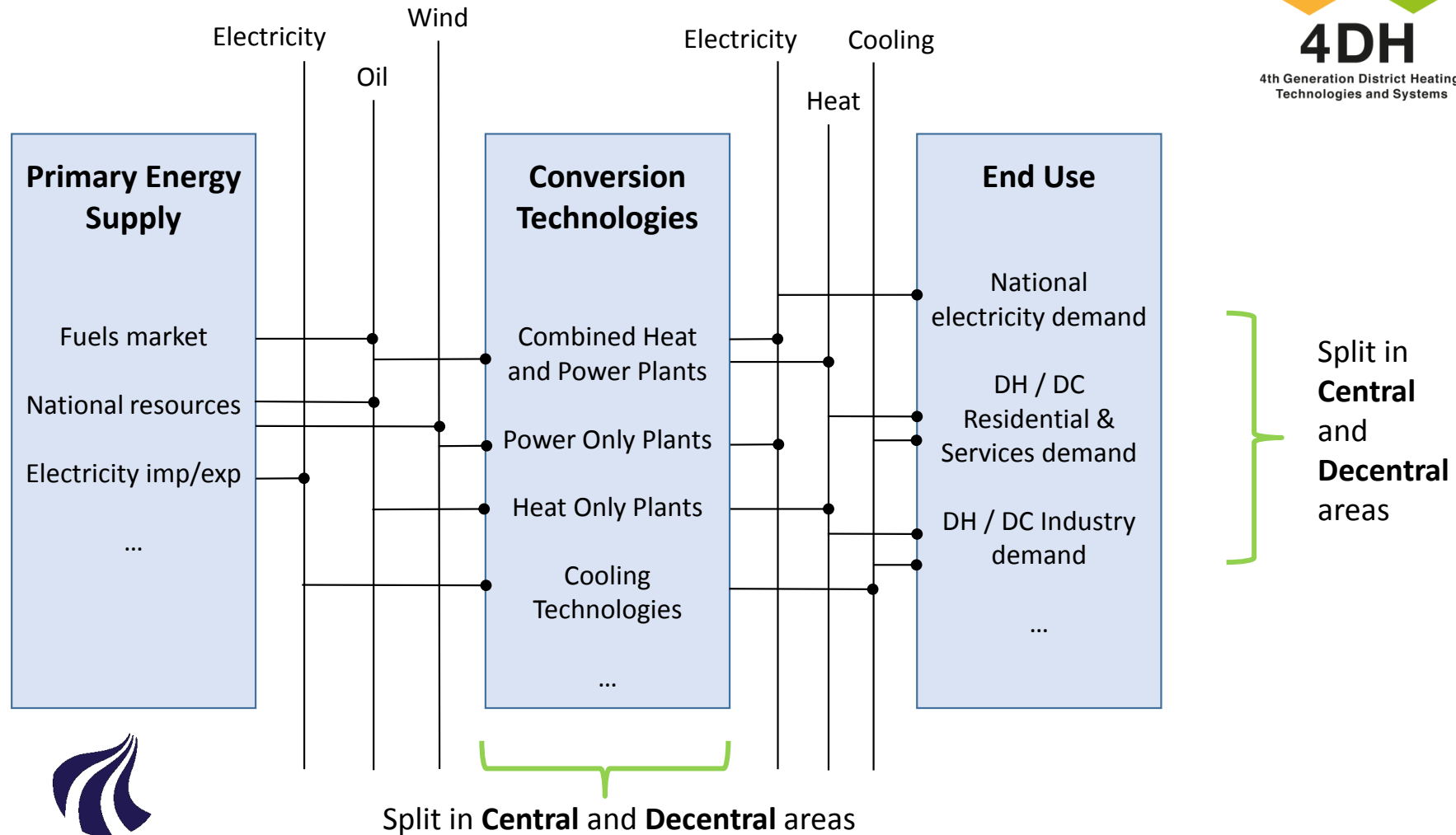
Target:

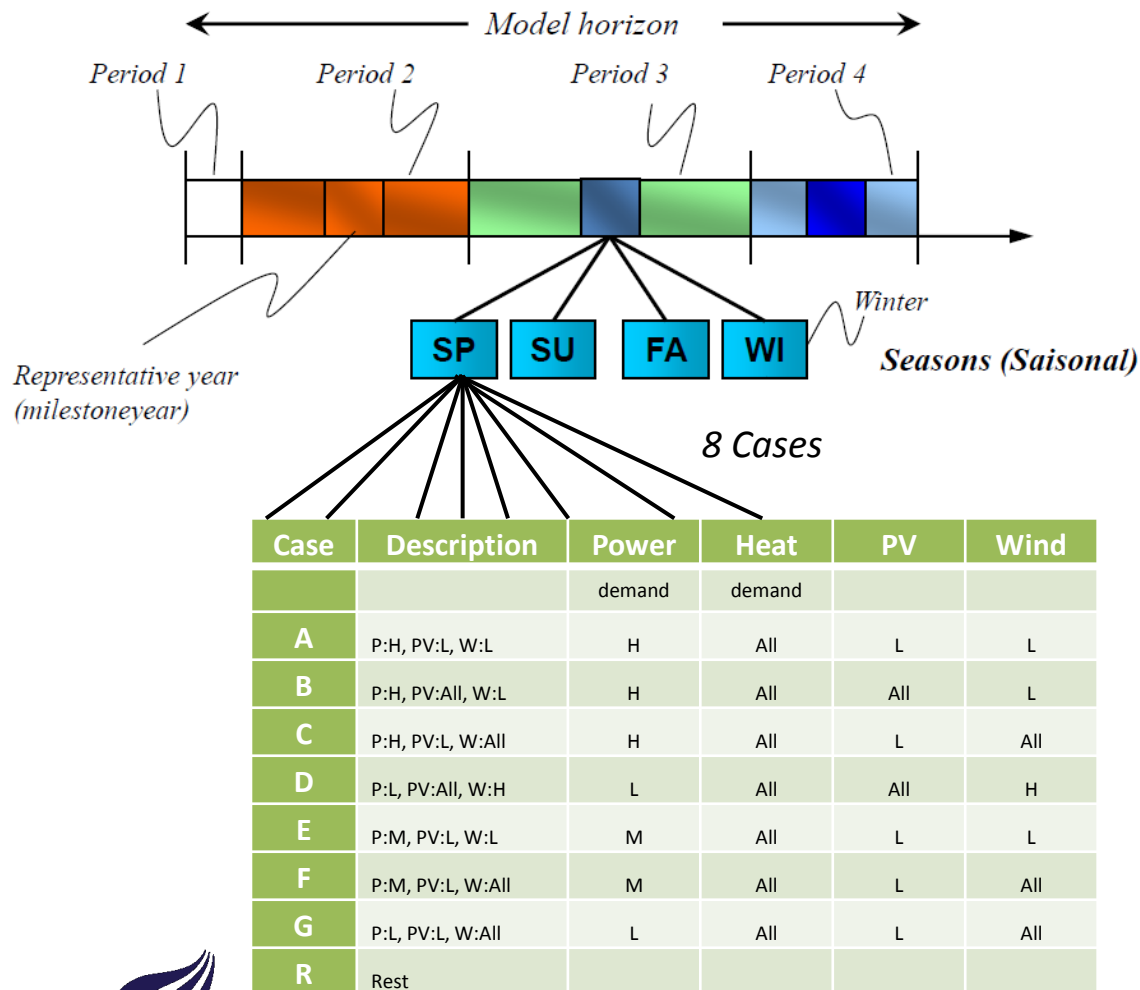- long-term analysis and planning of regional, national and multi-national energy systems.

Alternative worlds

Development pathways

Now

Future Scenario Analysis

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Models Features

Reference Energy System (by process) – based on **TIMES-DK**

Split in **Central** and **Decentral** areas

Models Features

Model horizon

Period 1   Period 2   Period 3   Period 4

Representative year (milestoneyear)

SP **SU** **FA** **WI**   *Winter*

Seasons (Saisonal)

8 Cases

Case	Description	Power	Heat	PV	Wind
		demand	demand		
A	P:H, PV:L, W:L	H	All	L	L
B	P:H, PV:All, W:L	H	All	All	L
C	P:H, PV:L, W:All	H	All	L	All
D	P:L, PV:All, W:H	L	All	All	H
E	P:M, PV:L, W:L	M	All	L	L
F	P:M, PV:L, W:All	M	All	L	All
G	P:L, PV:L, W:All	L	All	L	All
R	Rest				

32 Time Slices

- **Availability factors profiles** for Wind , Solar, Hydro
- Electricity, heat and cooling **demands profiles**
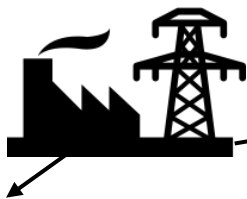- Electricity **import/export prices**
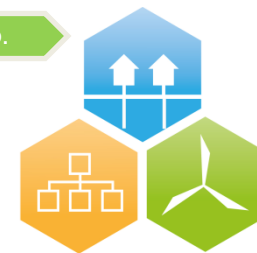
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entsoe
Transparency Platform

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Power Plants # Data Sources

Future Available Techs:
Economic, Technical and
Environmental features

Danish Energy Agency

JOINT RESEARCH CENTRE

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Existing Fleet:

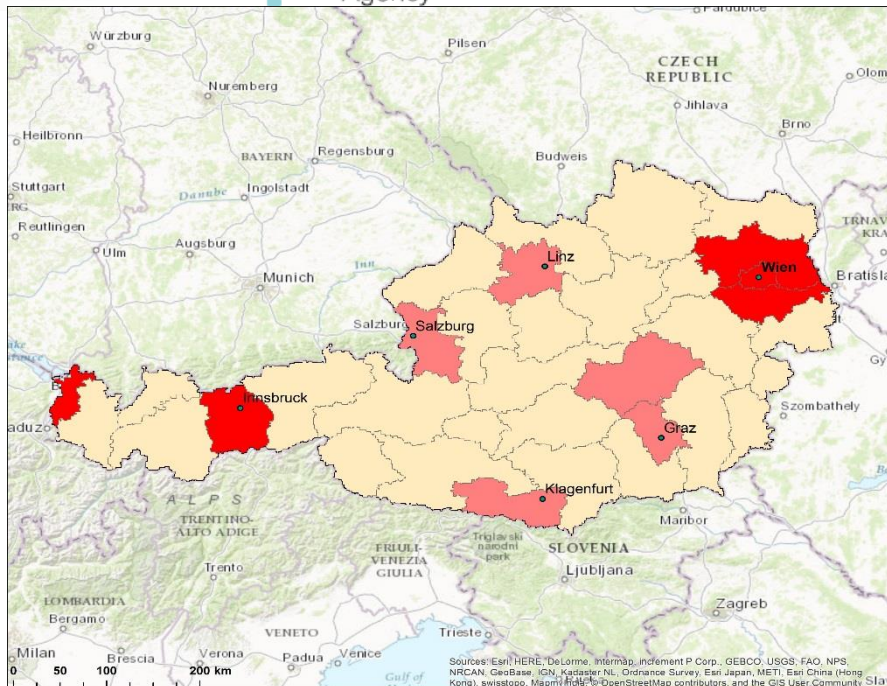Capacity (geo-located), Economic,
Technical, Environmental Features

S&P Global Platts

Danish Energy Agency

DTU

eurostat

El Demand & Energy Prices

$

PRIMES EU Reference Scenario 2016
- **Electricity demand projections**
- **Import/Export electricity prices projections**
- **Fuel prices projections** with & without taxes specific for each country

NUTS3 regions
Urban-rural topology
▢ Predominantly rural
▢ Intermediate
▢ Predominantly urban

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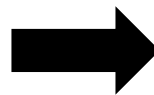4th Generation District Heating, Aalborg, 27-28 September 2016
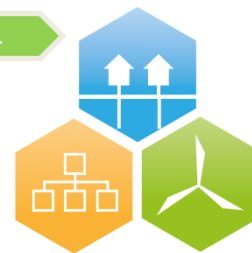
Data Sources

DH Demand & DC Potential

INVERT/EE-Lab model:

- Determines investments of building components and technologies
- **Residential** and **Services** buildings stock description for the whole country
- Bottom-up myopic model
- Provides **energy needs** in a high disaggregated level

Data Feed to TIMES

- DH demands split in **Central** and **Decentral** based on EU definition of Urban and non-Urban
- DC potential – Final cooling demand from **non-residential large buildings**

FORECAST-industry model:

- Forecast **energy demand** divided by processes given socioeconomic drivers
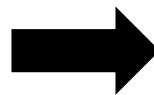- Bottom-up simulation model

Data Feed to TIMES

- DH demands split in NUTS3 regions based on industrial value added, then aggregated in **Central** and **Decentral**
- DC potential – Process cooling demand from **specific subsectors** (suitable for temperature range): **food..**
- Waste heat potential – waste heat from **specific subsectors** (suitable for temperature range): **steal**, **cement**..
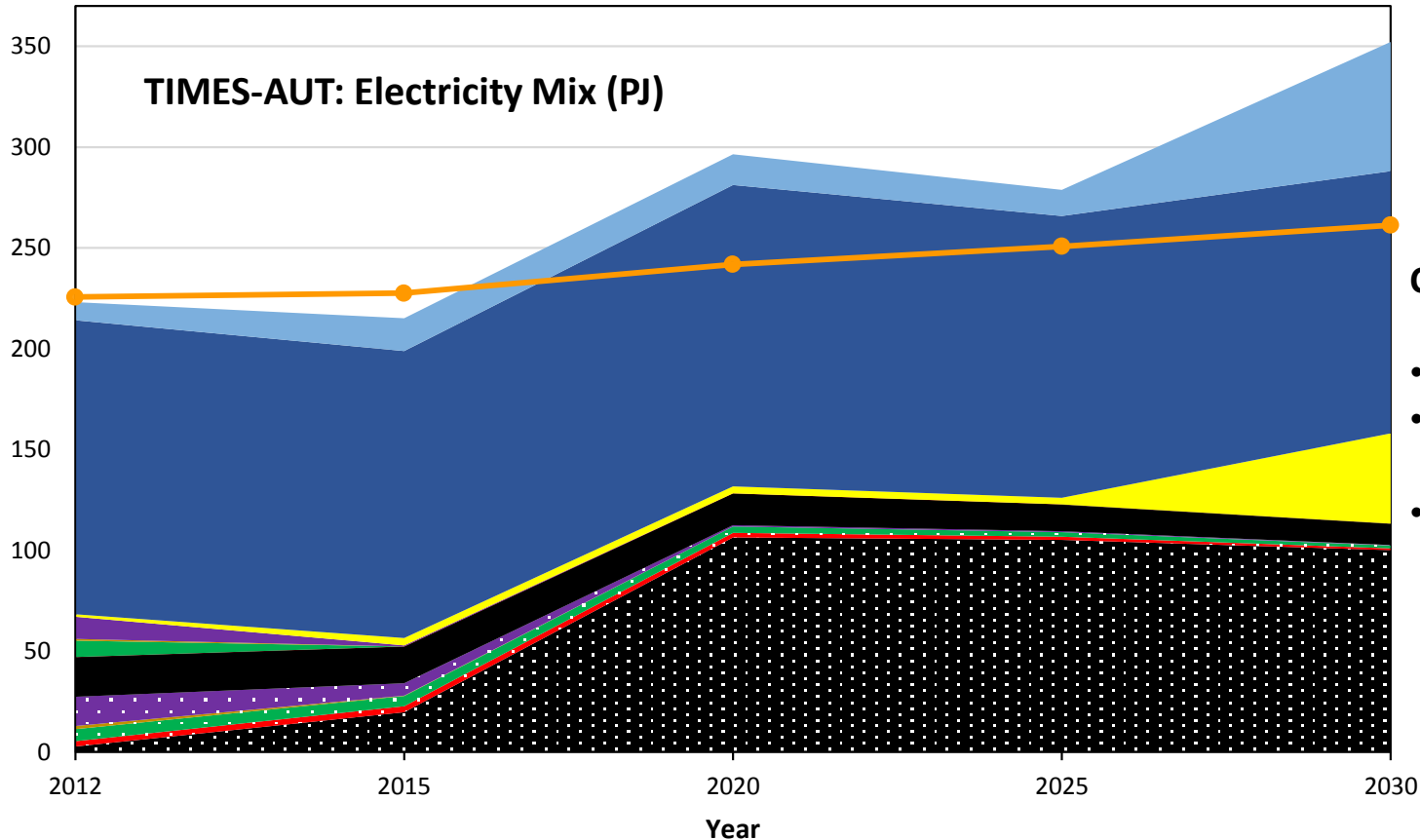
RES Potential

Green-X Database:

- EU-25 countries projections for **RES technologies deployment**
- Based on: **natural potential**, **regional distribution** and the corresponding **economic aspects**
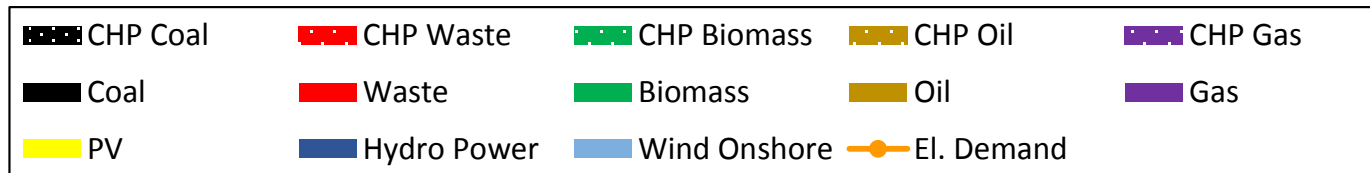
Data Feed to TIMES

- **RES Potentials** for each country

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Preliminary Results– TIMES-AUT

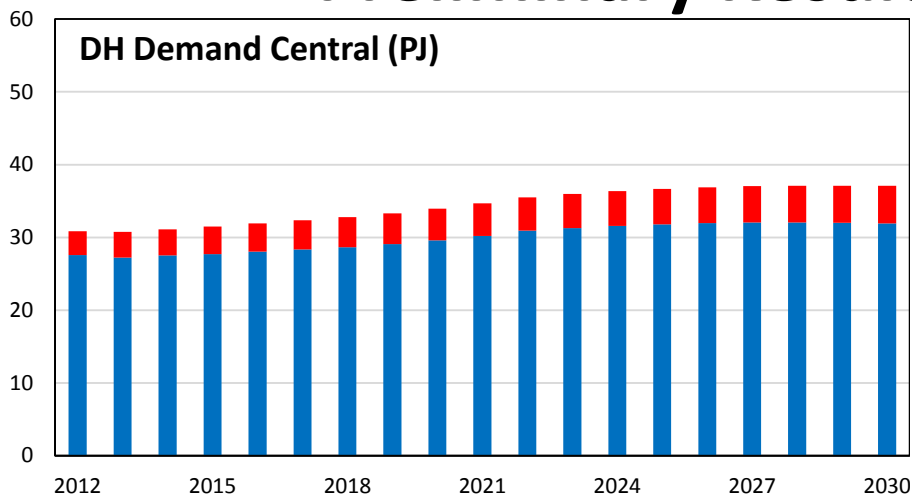**TIMES-AUT: Electricity Mix (PJ)**

Comments:

- Grid Losses = 8 %
- No Environ. Policies considered
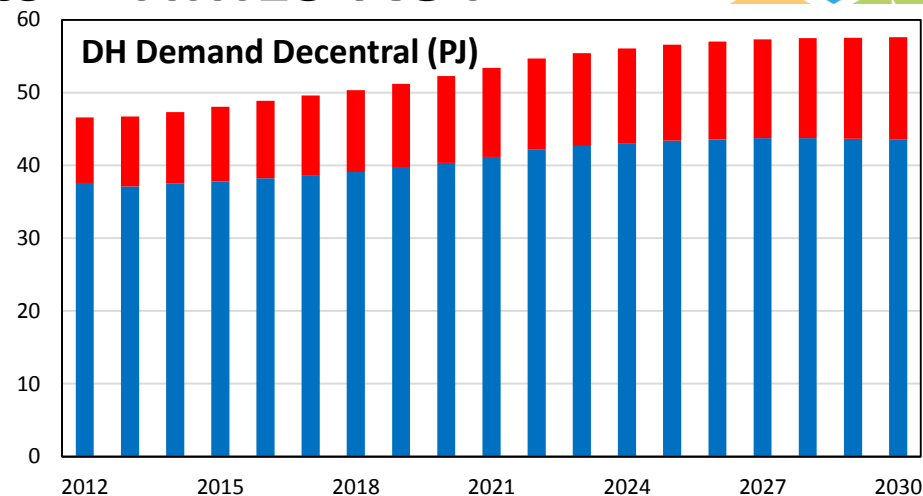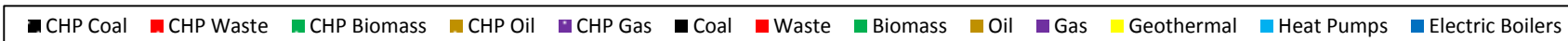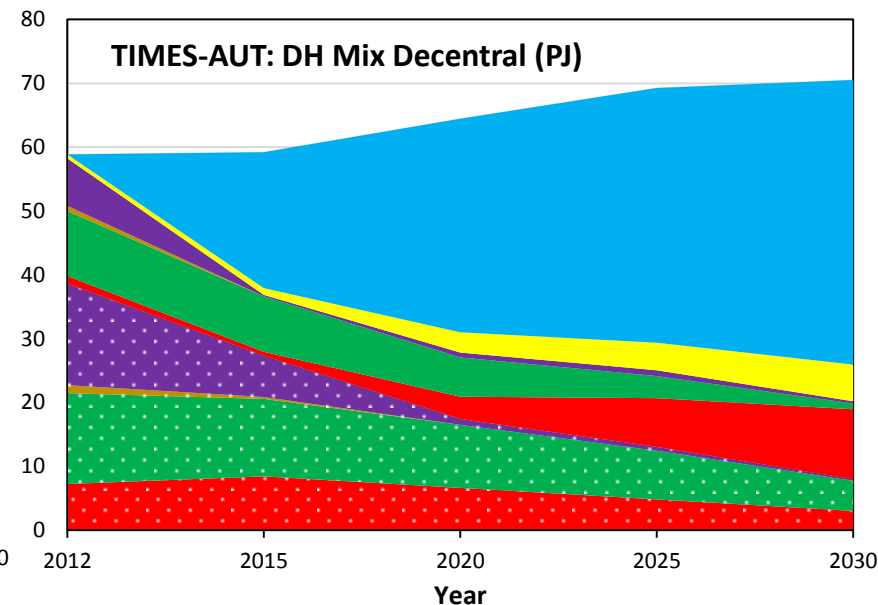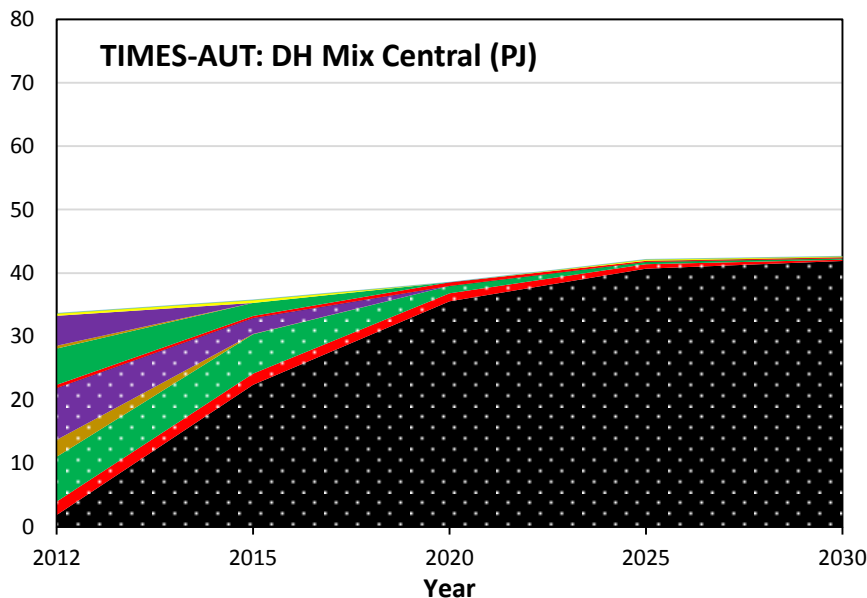- No costs for transmission lines expansion included

Legend: CHP Coal, CHP Waste, CHP Biomass, CHP Oil, CHP Gas, Coal, Waste, Biomass, Oil, Gas, PV, Hydro Power, Wind Onshore, El. Demand

Preliminary Results – TIMES-AUT

DH Demand Central (PJ)

Grid Losses = 13 %

DH Demand Decentral (PJ)

Grid Losses = 18 %

Legend: ■ Residential & Services ■ Industry

TIMES-AUT: DH Mix Central (PJ)

TIMES-AUT: DH Mix Decentral (PJ)

Legend: ■ CHP Coal ■ CHP Waste ■ CHP Biomass ■ CHP Oil ■ CHP Gas ■ Coal ■ Waste ■ Biomass ■ Oil ■ Gas ■ Geothermal ■ Heat Pumps ■ Electric Boilers

Further Developments

- Waste heat potential implementation

- District cooling implementation

- Model expansion costs for transmission lines

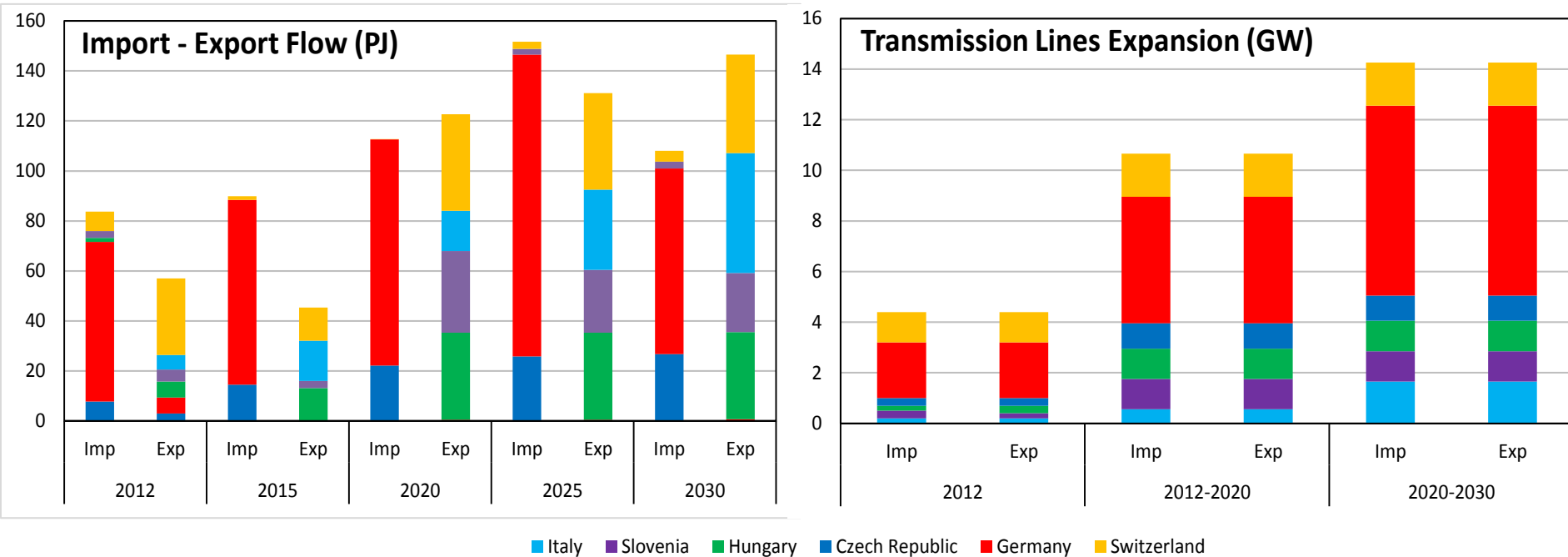- Additional criteria for Time Slices
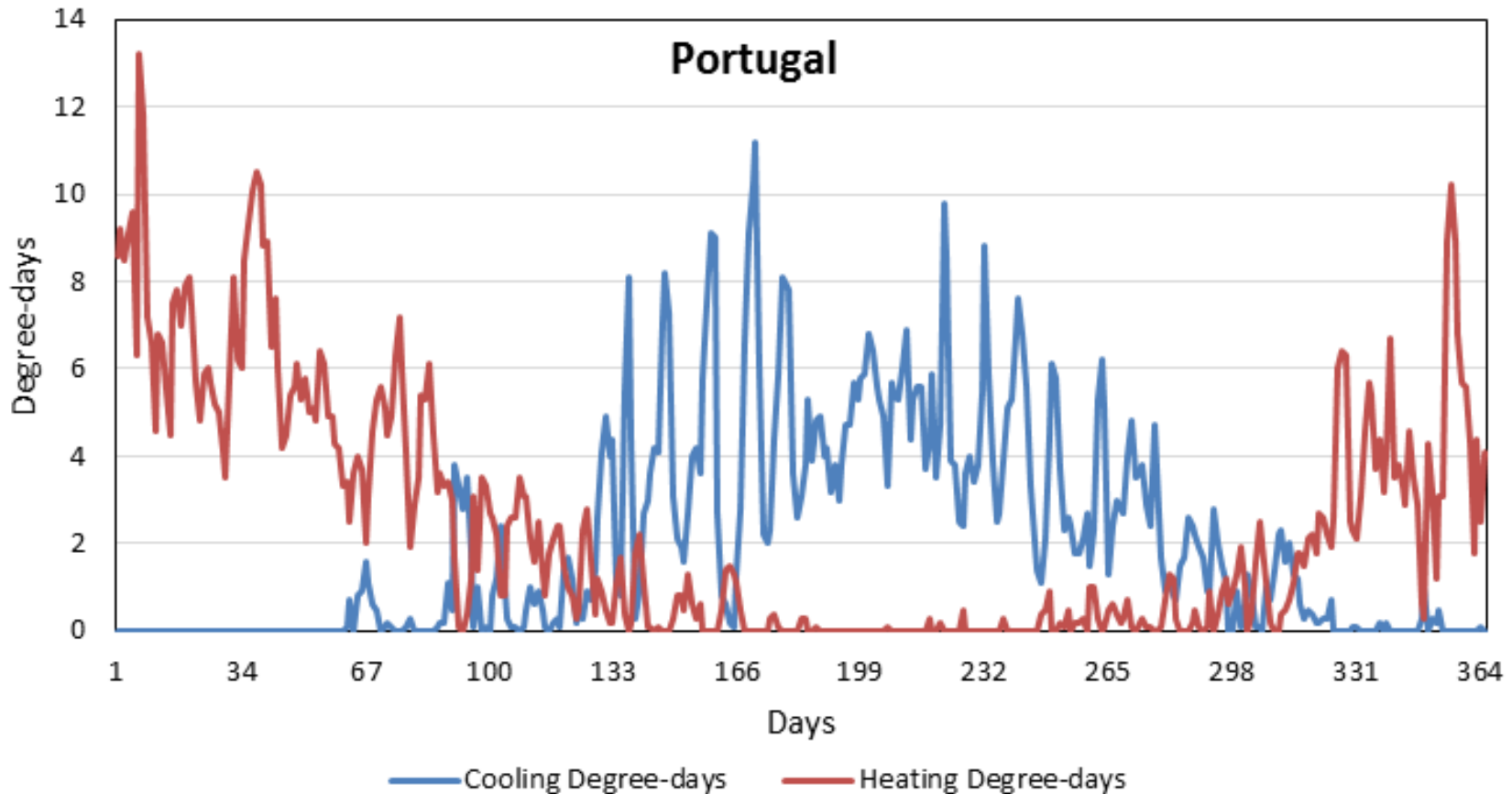
Thank you for your attention

Electricity Import Export

- No cost for expansion included

Import - Export Flow (PJ) — chart showing Imp/Exp values for 2012, 2015, 2020, 2025, 2030

Transmission Lines Expansion (GW) — chart showing Imp/Exp values for 2012, 2012-2020, 2020-2030

Legend: Italy, Slovenia, Hungary, Czech Republic, Germany, Switzerland
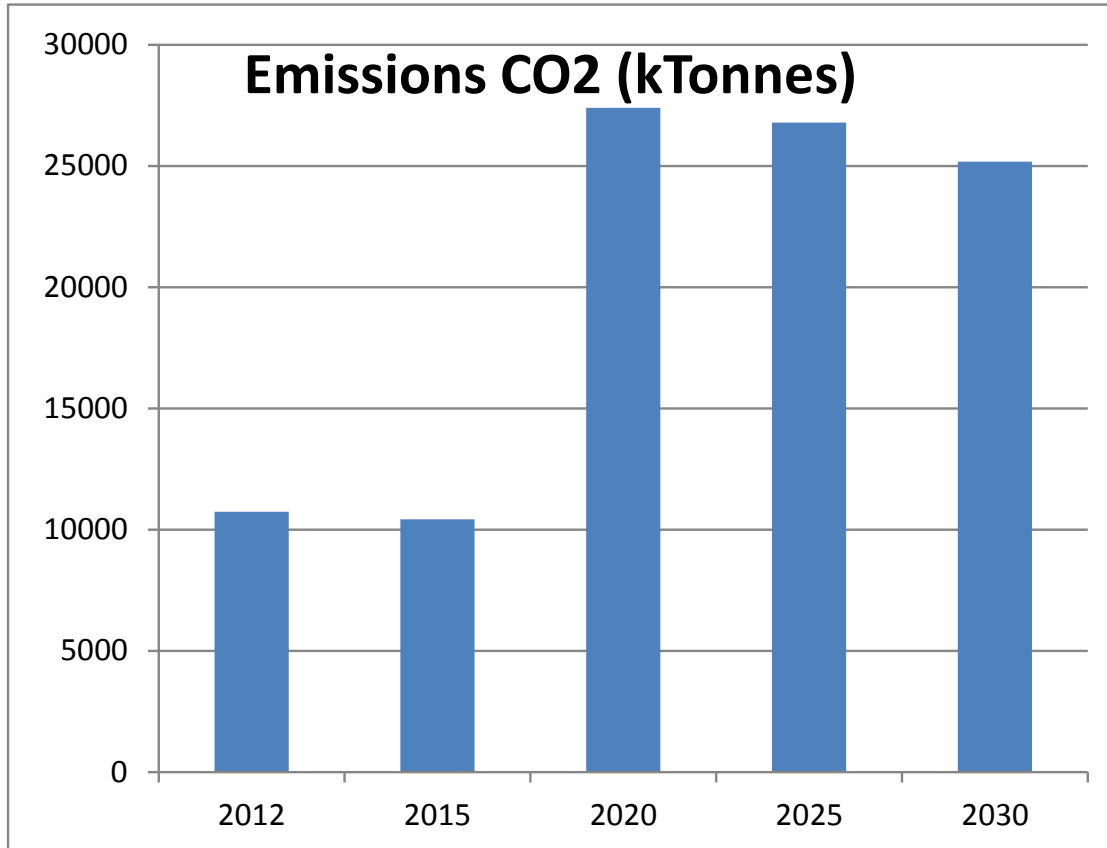
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Degree Days

- Degree days for each day of the year
- Normalization
- 25 % of DH demand is stable over the year (hot water)
- 75 % of DH demand follows the profile

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CO2 Emissions

Emissions CO2 (kTonnes)

Marginal Prices

- Calibration constraints make the base year marginal prices very high in comparison with the other years, where the model is less constrained

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