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Assessing Heat Pump Deployment for PNIEC Targets in Italy Through a Climate-Based Seasonal Performance Analysis

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ABSTRACT

Within the framework of EU policies promoting affordable, secure, and sustainable energy, the REPowerEU plan accelerates the Fit-for-55 targets, including the deployment of 10 million heat pumps (HPs) across the EU by 2027. In line with these objectives, Italy's 2024 Integrated National Energy and Climate Plan (PNIEC) sets a target for ambient renewable energy from heat pumps (ERES) to reach 5225 ktoe by 2030. This study quantifies the required regional deployment of heat pumps in Italy to meet the updated PNIEC targets. Regional energy consumption data for heating in residential and tertiary sectors were obtained from GSE reports. Assuming constant thermal demand over the years, uniform national targets were applied across regions. Useful heat and ERES fractions for the HPs were estimated using regionally weighted seasonal COPs based on climatic data from PVGIS-TMY, following UNI/TS 11300-4 standard. Required installed capacity was derived using regional Partial Load Factors (PLF) and suitable energy-to-power ratios. Despite an existing heat pump stock, most units are air-to-air systems mainly devoted to summer cooling, with limited heating use, highlighting potential grid impacts from widespread winter electrification (up to +8.05% of the total electric energy regional demand, with an average +4.03% in Italy).

1. INTRODUCTION

Nowadays, the need for the reduction of energy consumption is one of the main issues, from technical, economic, and environmental points of view. Buildings (residential and services) are responsible for about 40% of energy utilization and 36% of greenhouse gas emissions in European countries [1].

In this framework, European policies aimed at achieving more affordable, secure, and sustainable energy, and the REPowerEU plan [2] represents a major strategic response to both the climate crisis and the geopolitical urgency triggered by the disruption of fossil fuel supply chains, particularly due to the Russian invasion of Ukraine. As part of this strategy, the European Commission has committed to accelerating the Fit-for-55 [3] package by enhancing energy efficiency, increasing the use of renewable sources, and significantly reducing dependency on imported fossil fuels. A key component of this acceleration is the widespread deployment of heat pumps, with a target of installing 10 million additional units across the European Union by 2027 [2]. Heat pumps are considered a cornerstone technology in the decarbonization of the building sector, offering high energy efficiency and the potential to utilize ambient thermal energy for heating and domestic hot water production [3].

In alignment with these overarching EU objectives, the 2024 revision of Italy's Integrated National Energy and Climate Plan (PNIEC) outlines a national roadmap for energy transition, emphasizing the role of renewable thermal technologies. Specifically, the plan targets an increase in the share of ambient renewable energy from heat pumps, hereafter referred to as ERES, to 5225 ktoe of gross final thermal consumption by 2030 [4], with respect to 3052 ktoe in 2022.

Despite increasing heat pump sales in recent years, the majority of installed units in Italy are air-to-air reversible systems primarily used for cooling, with limited utilization for space heating during winter months, especially in multi-family buildings with centralized systems [5, 6]. Moreover, a large-scale shift from fossil-fuel-based heating to electric heat pumps may place additional stress on the electricity grid, particularly during winter peak demand periods, necessitating forward planning and investment in grid reinforcement and flexibility measures [7].

Against this backdrop, a more detailed regionally disaggregated assessment of the required heat pump deployment is essential to guide policy implementation and infrastructure planning.

Although a vast body of literature is dedicated to the accurate calculation of performance and the optimization of geothermal heat pump design [8, 9], their deployment is limited and more widespread in colder regions (Northern Europe) [10]; therefore, the present study is limited to considering the installation of heat pumps that use air as the heat source.

In this framework, this study contributes by estimating the regional distribution of heat pump installations needed to meet the PNIEC 2024 targets, taking into account regional thermal energy demands, climatic conditions, energy from renewable energy sources related to existing heat pumps, and system performance metrics such as seasonal coefficient of performance (sCOP) and partial load factors.

2. MODELING AND METHODOLOGY

2.1 Meteorological data acquisition

To determine the seasonal performance (sCOP) of heat pump (HP) systems all over the Italian territory at provincial level, the Typical Meteorological Year (TMY) for each provincial capital has been analyzed. Given the coordinates of each province capital, the corresponding TMY file has been downloaded from the PVGIS SARAH-3 database, for a total of 109 locations in the 21 Italian regions. Among the different data provided in TMY files, the hourly air temperature values have been considered.

The present investigation is related to the heating period. The Italian D.P.R. August 26, 1993, n. 412 [11] established the division of the national territory into six climate zones (A–F), based on the heating degree days (HDD) of each municipality. Moreover, the D.P.R. April 16, 2013, n. 74 [12] regulates the periods during which the operation of heating systems is permitted, as shown in Table 1. In each considered location, the analysis has been restricted to the corresponding heating period.

Table 1. Climatic zones in Italy

Climatic Zone	HDD	Heating Period
A	<600	December 1 – March 15
B	600-900	December 1 – March 31
C	901-1400	November 15 – March 31
D	1401-2100	November 1 – April 15
E	2101-3000	October 15 – April 15
F	>3000	No restrictions

For each location, the design temperature to be used for the simulation was determined. For each consecutive 12-hour interval, the maximum temperature is calculated. The design temperature is the minimum value, over the course of a year, among all these maximum temperatures over 12 consecutive hours. Therefore, the design temperature T_{des} has been set as the temperature value below which the external air temperature does not remain for more than 12 consecutive hours during the year.

2.2 Performance estimation of heat pumps

2.2.1 Analyzed model

The present analysis refers to an air-to-air HP, sized for an average 1 family residential unit. Since the coefficient of performance (COP) of an HP is more dependent on the specific model rather than its size, only one model has been considered within the present investigation. The performances of the selected model satisfy the D.M. August 6, 2020, Annex F [13], which establishes the minimum performances for heat pumps to have access to tax incentives. In particular, for air-to-air HP, the minimum COP is 3.9, evaluated at external and internal air temperatures of $T_{ext} = 7°C$, $T_{int} = 20°C$.

Tables 2 and 3 report the declared performances of the selected air-to-air inverter-type HP. The performance data are expressed in accordance with the Italian Standard UNI/TS 11300-4 [14]. The capacity ratio CR is here the ratio between the actual heating demand and the maximum heating capacity at the same operating conditions, while fCOP is the ratio between the COP at partial load and the COP at full load at the same operating conditions.

Table 2. Selected heat pump performance at full load

External Air Temperature [°C]	Heating Capacity [kW]	COP [-]
-7	10.53	2.65
-2	11.31	2.71
7	16.00	3.91
12	16.00	4.49

Table 3. Selected heat pump performance at partial load

External Air Temperature [°C]	Capacity Ratio [-]	Heating Demand [kW]	COP [-]	fCOP
-7	100%	10.53	2.65	1.00
-2	57%	6.46	2.96	1.09
7	26%	4.19	4.12	1.05
12	11%	1.79	4.17	0.92

2.2.2 Climatic load curve

For each location, the heating demand has been set to 100% at the design temperature T_{des} (evaluated as described in paragraph 2.1) and 0% at $T_{ext} = 16°C$, following the linear law for the building climate load factor as in Eq. (1).

$$PLR = \frac{T_{\text{ext}} - 16}{T_{\text{des}} - 16} \tag{1}$$

Setting the heating demand at T_{des} equal to the maximum heating capacity of the selected HP at T_{des}, the heating demand as a function of external air temperature T_{ext} can be determined.

The Capacity Ratio (CR) is calculated for each T_{ext} as the ratio between the heating demand and the maximum heating capacity under the same operating conditions.

2.2.3 Heat pump performance at full and partial load

For T_{ext} different from the 4 conditions reported in Table 2, the maximum heating capacity has been calculated with linear interpolation, and extrapolated for temperatures below -7°C. However, to calculate COP values at full load, the Italian Standard UNI/TS 11300-4 [14] suggests not to directly interpolate the COP.

First, the Carnot efficiency COP_{max} is calculated for each of the external air temperatures T_{ext} of Table 2, considering the internal air temperature $T_{int} = 20°C$, as in Eq. (2):

$$COP_{\max} = \frac{T_{int} + 273.15}{T_{int} - T_{ext}} \tag{2}$$

Then, the second law efficiency η_{II} for each declared point in Table 2 is calculated as the ratio between COP and COP_{max}. Therefore, for any different T_{ext}, the η_{II} is calculated by interpolating between the 4 calculated points. For $T_{ext} < -7$ °C, the second law efficiency is considered to be constant. The COP at full load at each T_{ext} can be calculated by multiplying

COP_{max} by the corresponding second law efficiency η_{II}.

Finally, as suggested by UNI/TS 11300-4 Standard [14], it is assumed that fCOP depends solely on CR and the relationship between fCOP and CR is assumed to be linear between any point pair (CR, fCOP) of Table 3; thus, the fCOP values can be estimated for all the required T_{ext}, allowing finally to calculate the partial load performance.

2.2.4 Heat pump seasonal performance

For each location and within the heating period relative to the corresponding climatic zone, the HP hourly performance has been evaluated as explained in the previous sections, in terms of COP, heating demand, and CR. In addition, the partial load factor (PLF) is calculated as in Eq. (3):

$$PLF = \frac{\text{Heating demand}}{HP \text{ rated power}} \tag{3}$$

where the HP rated power is the maximum heating capacity at T_{ext} = 7°C, T_{int} = 20°C. The seasonal PLF (sPLF) has been calculated as the average hourly PLF.

The seasonal energy to power ratio (sEPR) has been calculated by multiplying the sPLF by the number of hours of the heating period for each location.

Since the energy demand is not constant throughout the heating period, the seasonal coefficient of performance (sCOP) is calculated as the average hourly COP weighted on the hourly PLF, as in Eq. (4):

$$sCOP = \frac{\sum_{i=1}^{N} COP_i \cdot PLF_i}{\sum_{i=1}^{N} PLF_i} \tag{4}$$

where, N is the number of hours of the heating period.

As defined in the European Directive RED II [15], the seasonal energy share from renewable energy sources (sERES) has been calculated as in Eq. (5):

$$sERES = 1 - \frac{1}{sCOP} \tag{5}$$

Finally, the Regional sCOP, sERES, sPLF, sEPR have been calculated as the average of the provincial values weighted on the provincial population.

2.3 Estimation of the new HP fleet in Italy

The Italian PNIEC plan foresees that by 2030, heat pumps will contribute to the renewable energy fraction ERES globally equal to 5225 ktoe [4]. Based on the analysis of data provided by the GSE for each region [16], in 2022 the 8.7% of the demand for heating in the residential and services sector was covered by ERES from heat pumps (2746 ktoe over a demand of 31467 ktoe). Assuming that the heating demand remains almost unchanged, by 2030, the ERES fraction from HP is expected to cover 16.6% of the heating demand in the residential and services sector. Thus, in this preliminary analysis, it has been assumed that all regions will reach the same 16.6% target.

Taking into account the GSE 2022 data, for each Italian region, the additional ERES quote to be achieved by 2030 has been calculated and called $ERES_{add}$.

The regional heating demand Q_h covered by new HPs in 2030 has been estimated as in Eq. (6):

$$Q_{h,\text{add}} = \frac{\text{ERES}_{\text{add}}}{sERES} \tag{6}$$

The regional electric energy demand (E_{el}) associated with additional HPs operation has been estimated as in Eq. (7):

$$E_{el,add} = \frac{Q_{h,add}}{sCOP} \tag{7}$$

The regional additional HP installed power $P_{inst,\,add}$ has been estimated through the calculated seasonal energy to power ratio as in Eq. (8):

$$P_{\text{inst, add}} = \frac{Q_{h,\text{ add}}}{sEPR} \tag{8}$$

Finally, the impact of the installation of new HPs has been evaluated through the comparison of the additional electrical energy demand $E_{el,\,add}$ respect to the electrical energy demand of each region in the residential and tertiary sectors and the total electrical energy demand. The electrical energy demand data have been retrieved from the 2023 statistics of Terna [17].

3. RESULTS AND DISCUSSION

Figures 1 to 3 show the ERES from HPs of each region in 2022, as declared by GSE, with respect to the additional ERES from newly installed HPs necessary to reach the PNIEC target. As previously stated, the main hypothesis is to cover the missing ERES with HPs for heating.

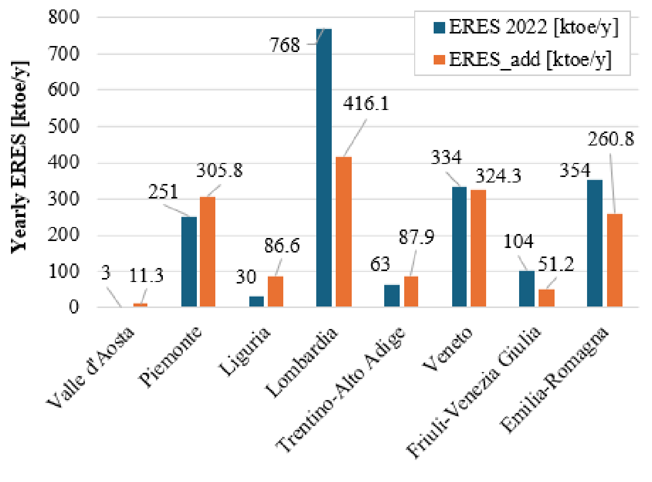

Figure 1. Current (2022) and additional yearly ERES at 2030 from HPs in Northern Italy

It is evident that the main contributors to the HP present and future installations in Italy are the main thermal energy consumers, mostly located in the larger regions in Northern Italy. In regions like Sicily and Sardinia, since the use of HPs is largely diffused for cooling in summer and, in addition, the winter temperatures are relatively high, the use of HPs for both cooling and heating is already widespread. The Sicilian PEAR 2030 (Piano Energetico Ambientale Regionale) [18] shows that the ERES from HPs in Sicily was already around 98 ktoe in 2015. It has to be emphasized that the current European regulations have established a calculation methodology that defines the amount of renewable energy used also for cooling and district cooling [19].

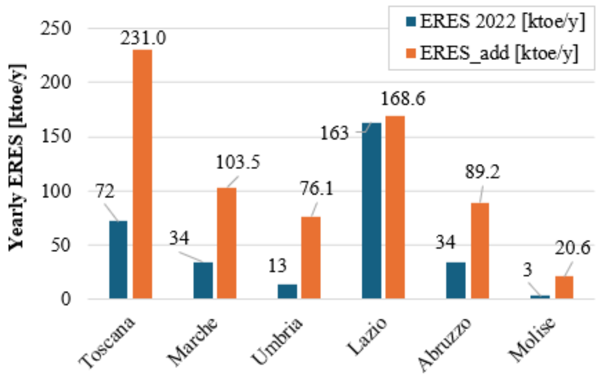

Figure 2. Current (2022) and additional yearly ERES at 2030 from HPs in Central Italy

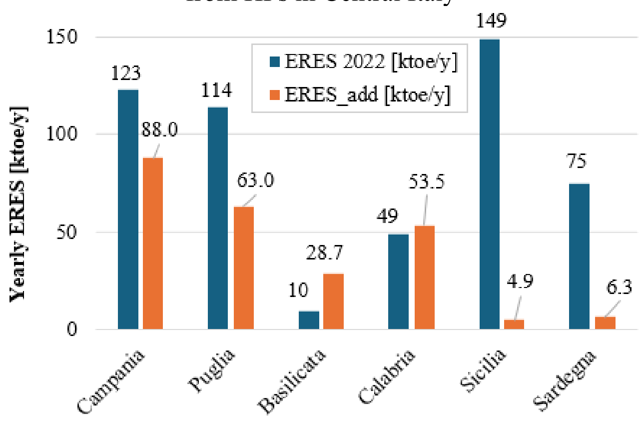

Figure 3. Current (2022) and additional yearly ERES at 2030 from HPs in Southern Italy and the islands

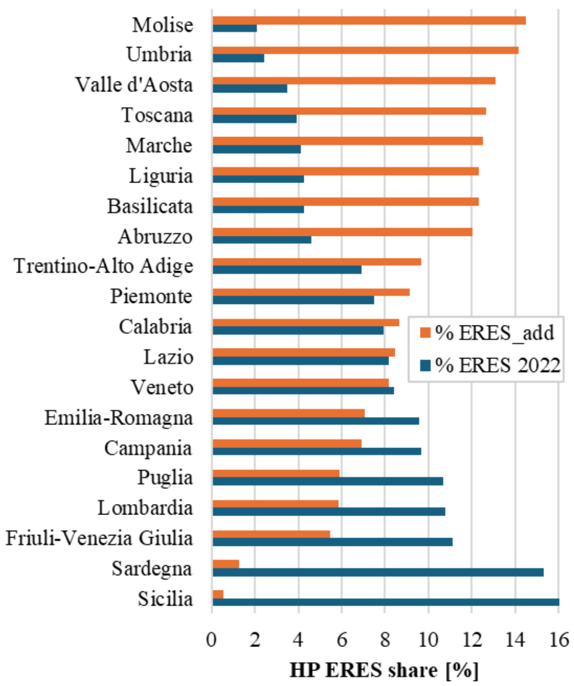

Figure 4. Current (2022) and additional ERES shares from HPs in the Italian regions

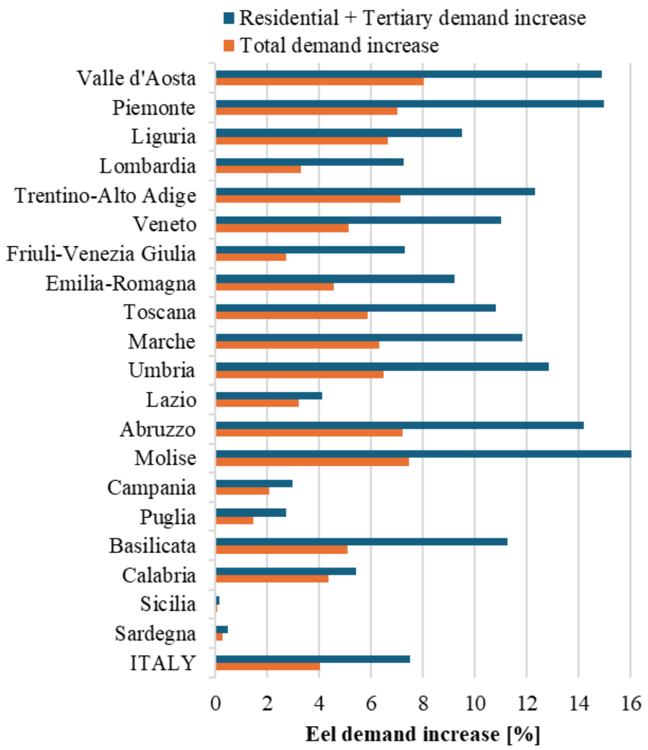

Figure 5. Electrical energy demand increases for additional HPs with respect to demand in 2023 in the Residential + Tertiary sectors and with respect to overall energy demand in 2023

Figure 4 shows the 2022 ERES contribution to thermal energy needs and the necessary new ERES share to reach the PNIEC target. In certain regions HPs for heating are less diffused (lower ERES share at 2022) for a combination of climatic, economic, infrastructural, and cultural factors, such as: lower HP efficiency at lower temperatures (mountainous regions), higher initial costs against a low perception of lower operational costs, widespread gas infrastructure and resistance to innovation, diffusion of biomass heating systems [20].

From the point of view of HP seasonal performance, the seasonal partial load factor sPLF ranged from 0.28 (Trentino-Alto Adige) to 0.45 (Sardinia), with an average of 0.35 in Italy. A lower sPLF is expected in locations with a low design temperature and colder climate, where the HP works mainly at lower power with respect to the rated on. All the data are presented in the Appendix, where the last rows of each table report the minimum, maximum, and average values for each column.

Figure 5 shows the electricity demand increase due to new HPs with respect to the current (2023) electrical energy demand in the residential + tertiary sector and with respect to the overall regional electrical energy demand. A higher impact on the energy demand can be related to higher new HP installed power or lower regional electrical energy demands due to limited presence of industry, or both reasons, such as in Molise or Valle d'Aosta.

The impact of a largely increased demand in the residential + tertiary sector can be difficult to manage for the existing electrical grid in contexts in which the additional demand is concentrated in small areas far from the energy production sites. The diffusion of distributed renewable energy generation sources, such as rooftop PV, can help to mitigate the critical effect of increased energy demand [21].

The Appendix section reports the calculated values of design temperature T_{des}, sCOP, sERES share, sPLF for each Italian Province and Region. In the last rows of the tables, the maximum, minimum, and average value of each column is presented.

4. CONCLUSIONS

This study presents a comprehensive simulation-based analysis of air-to-air heat pump performance across all Italian provinces, accounting for local hourly climatic conditions (TMY) and heating periods.

The results show significant regional differences in seasonal performance (sCOP), ranging from 2.8 to 4.44, and renewable energy share (sERES) from 0.64 to 0.77.

Northern regions, with higher heating demands, are expected to play the largest role in expanding Italy's heat pump fleet to meet PNIEC targets. However, colder climates and existing reliance on gas infrastructure may hinder the deployment. Conversely, southern regions and islands, particularly Sicily, have already achieved substantial ERES contributions due to milder winters and dual-use (cooling/heating) applications, remembering that the current European regulations have defined the estimation of the amount of renewable energy used also for HPs in cooling mode.

Achieving the 2030 national goals will require significant new installations in underperforming regions. This will lead to a measurable increase in electricity demand (up to +8.05% of the total regional demand, with an average of +4.03% in Italy), which may challenge local grids, especially in low-demand regions. The integration of distributed renewable sources, such as PV systems, is essential to ensure grid stability. Overall, heat pumps remain a viable solution for decarbonizing residential and tertiary heating in Italy.

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NOMENCLATURE

COP	coefficient of performance
CR	capacity ratio
E	energy, GWh
EPR	energy to power ratio, kWh.kW-1
ERES	renewable energy from heat pumps [ktoe]
fCOP	ratio between COP at partial and full load at the same operating conditions
HDD	heating degree day, HDD
P	power, GW
PLF	partial load factor
sCOP	seasonal coefficient of performance
PLF	partial load factor
PLR	building partial load ratio
Q	thermal energy demand, ktep
sEPR	seasonal Energy to power ratio, kWh.kW-1
sERES	seasonal share of renewable energy from heat pumps
sPLF	seasonal partial load factor
T	temperature, °C

Greek symbols

η_{II}	second law efficiency

Subscripts

add. HPs	related to new HP installations, to meet the PNIEC 2024 objectives at 2030
des	design
el	electric
ext	external
h	heating
inst	installed
int	internal
max	maximum

Acronyms

DM	Ministerial Decree
DPR	"Decreto del Presidente della Repubblica", Presidential Decree
EU	European Union
GSE	"Gestore Servizi Energetici", Italian Energy Services Manager
HP	Heat Pump
PEAR	"Piano Energetico Ambientale Regionale", Regional Environmental Energy Plan
PNIEC	Integrated National Energy and Climate Plan
PVGIS	Photovoltaic Geographical Information System
RED	Renewable Energy Directive
TMY	Typical Meteorological Year
UNI/TS	Italian National Unification Body/Technical Specification

APPENDIX

Table 4. Calculated design temperature and HP performances in each Italian province

Province	T_{des}	sCOP	sERES	sPLF	sEPR
Agrigento	2.7	4.1	0.76	0.36	1040
Alessandria	-1.7	3.5	0.71	0.34	1496
Ancona	5.7	4.5	0.78	0.47	1878
Andria	1.0	3.9	0.74	0.35	1154
Aosta	-18.7	2.8	0.64	0.34	1490
Arezzo	-2.5	3.5	0.71	0.34	1501
Ascoli Piceno	-5.5	3.3	0.70	0.35	1398
Asti	-8.2	3.3	0.69	0.28	1235
Avellino	-3.0	3.7	0.73	0.32	1259
Bari	5.0	4.3	0.77	0.44	1452
Barletta	2.6	4.2	0.76	0.40	1303
Belluno	-6.9	3.2	0.69	0.23	2008
Benevento	-2.7	3.6	0.72	0.32	1058
Bergamo	-3.6	3.2	0.69	0.37	1620
Biella	-5.3	3.2	0.69	0.38	1654
Bologna	-1.2	3.6	0.72	0.35	1557
Bolzano	-11.2	3.1	0.67	0.34	1498
Brescia	-1.4	3.5	0.72	0.38	1672
Brindisi	2.9	4.3	0.77	0.31	1004
Cagliari	6.3	4.7	0.79	0.39	1274
Caltanissetta	1.6	3.8	0.74	0.34	1372
Campobasso	-2.8	3.5	0.71	0.34	1472
Carbonia	4.8	4.4	0.77	0.35	1154
Caserta	1.3	3.8	0.74	0.36	1176
Catania	4.1	4.4	0.77	0.34	995
Catanzaro	1.5	4.0	0.75	0.31	1024
Chieti	-1.1	3.5	0.71	0.35	1399
Como	-8.4	3.2	0.68	0.31	1342
Cosenza	-0.2	3.7	0.73	0.38	1241
Cremona	-7.5	3.3	0.70	0.28	1222
Crotone	3.2	4.5	0.78	0.23	665
Cuneo	-9.6	3.2	0.69	0.20	1792
Enna	0.6	3.7	0.73	0.32	1413
Fermo	1.1	4.0	0.75	0.33	1303
Ferrara	-2.0	3.3	0.70	0.35	1536
Firenze	-2.9	3.5	0.72	0.33	1330
Province	T_{des}	sCOP	sERES	sPLF	sEPR
Foggia	-0.9	3.8	0.74	0.30	1193
Forlì	-5.6	3.4	0.71	0.28	1122
Frosinone	-3.8	3.4	0.71	0.28	1247
Genova	-1.7	3.5	0.72	0.36	1416
Gorizia	-9.2	3.3	0.70	0.28	1210
Grosseto	2.6	4.2	0.76	0.34	1347
Imperia	0.5	3.8	0.74	0.38	1259

Province	T_{des}	sCOP	sERES	sPLF	sEPR
Isernia	-5.1	3.4	0.70	0.35	1406
La Spezia	4.0	4.3	0.77	0.43	1696
L'Aquila	-5.8	3.2	0.69	0.37	1639
Latina	4.2	4.2	0.76	0.41	1348
Lecce	3.0	4.3	0.77	0.29	968
Lecco	-4.2	3.2	0.69	0.38	1650
Livorno	0.0	3.8	0.74	0.32	1272
Lodi	-4.3	3.3	0.70	0.34	1502
Lucca	-1.2	3.5	0.71	0.38	1498
Macerata	-2.0	3.5	0.72	0.32	1281
Mantova	-0.8	3.5	0.72	0.34	1510
Massa	2.6	4.1	0.76	0.42	1668
Matera	0.1	3.8	0.73	0.31	1247
Messina	5.2	4.7	0.79	0.35	1004
Milano	-2.9	3.3	0.70	0.35	1557
Modena	-5.1	3.5	0.71	0.28	1218
Monza	-4.2	3.4	0.70	0.33	1457
Napoli	1.6	4.2	0.76	0.31	1005
Novara	-2.2	3.3	0.70	0.35	1554
Nuoro	1.2	3.9	0.74	0.36	1442
Oristano	4.0	4.3	0.77	0.41	1360
Padova	-3.1	3.5	0.71	0.31	1365
Palermo	4.8	4.6	0.78	0.39	1135
Parma	-2.5	3.5	0.71	0.31	1376
Pavia	-3.5	3.5	0.72	0.30	1327
Perugia	-2.2	3.5	0.71	0.34	1485
Pesaro	1.7	4.3	0.77	0.29	1151
Pescara	-2.1	3.7	0.73	0.31	1218
Piacenza	-3.0	3.5	0.71	0.33	1449
Pisa	-2.2	3.7	0.73	0.28	1113
Pistoia	-2.8	3.3	0.70	0.37	1482
Pordenone	-2.6	3.4	0.70	0.33	1454
Potenza	-6.0	3.4	0.71	0.30	1303
Prato	-2.1	3.5	0.71	0.36	1433
Ragusa	3.7	4.3	0.77	0.40	1307
Ravenna	-2.4	3.8	0.74	0.27	1186
Reggio Calabria	0.5	3.8	0.74	0.41	1194
Reggio nell'Emilia	-1.8	3.5	0.71	0.34	1504
Rieti	-5.7	3.4	0.70	0.32	1403
Rimini	-1.5	3.8	0.74	0.30	1303
Province	T_{des}	sCOP	sERES	sPLF	sEPR
Roma	3.3	4.1	0.76	0.36	1439
Rovigo	-2.4	3.4	0.70	0.33	1439
Salerno	0.0	4.0	0.75	0.30	999
Sassari	5.6	4.3	0.77	0.57	1864
Savona	-0.3	3.7	0.73	0.36	1421
Siena	-2.5	3.5	0.72	0.34	1361
Siracusa	8.3	4.9	0.80	0.43	1260

Province	T_{des}	sCOP	sERES	sPLF	sEPR
Sondrio	-15.6	2.9	0.66	0.34	1476
Taranto	0.1	4.1	0.76	0.22	734
Teramo	-1.2	3.4	0.71	0.41	1643
Terni	-5.1	3.4	0.70	0.32	1277
Torino	-2.2	3.3	0.69	0.41	1790
Trani	-1.5	3.8	0.74	0.27	903
Trapani	4.9	4.4	0.78	0.38	1100
Trento	-7.1	3.4	0.70	0.21	1848
Treviso	0.0	3.7	0.73	0.36	1600
Trieste	-4.5	3.4	0.71	0.32	1389
Udine	-3.9	3.4	0.71	0.33	1446
Varese	-1.7	3.4	0.71	0.37	1608
Venezia	1.5	3.9	0.74	0.35	1548
Verbania	-3.4	3.3	0.70	0.38	1686
Vercelli	-8.8	3.3	0.69	0.25	1120
Verona	-1.8	3.4	0.71	0.33	1455
Vibo Valentia	4.2	4.4	0.77	0.34	1345
Vicenza	-1.7	3.4	0.70	0.36	1601
Viterbo	-0.9	3.5	0.71	0.38	1494
MIN Values	-18.7	2.8	0.64	0.27	65
MAX Values	+8.3	4.4	0.77	0.44	2008

Table 5. Calculated design temperature and HP performances in each Italian region

Region	sCOP	sERES	sPLF	EPR
Valle d'Aosta	2.8	0.64	0.34	1490
Piemonte	3.3	0.70	0.35	1679
Liguria	3.7	0.73	0.37	1435
Lombardia	3.3	0.70	0.35	1536
Trentino-Alto Adige	3.2	0.69	0.28	1675
Veneto	3.5	0.72	0.34	1528
Friuli-Venezia Giulia	3.4	0.71	0.32	1410
Emilia-Romagna	3.5	0.72	0.32	1380
Toscana	3.6	0.72	0.34	1373
Marche	4.0	0.75	0.36	1454
Umbria	3.4	0.71	0.33	1432
Lazio	4.0	0.75	0.36	1416
Abruzzo	3.5	0.71	0.36	1467
Molise	3.4	0.71	0.34	1454
Region	sCOP	sERES	sPLF	EPR
Campania	4.0	0.75	0.32	1052
Puglia	4.2	0.76	0.34	1138
Basilicata	3.5	0.72	0.30	1283
Calabria	3.9	0.75	0.36	1145
Sicilia	4.4	0.77	0.37	1119
Sardegna	4.4	0.77	0.45	1503
ITALY	3.7	0.73	0.35	1381