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Phase 1: Demand Extrapolation

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www.digital-engineering-ltd.com
+44 (0) 117 214 0405

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Revision History

Version No.	Details	Authorised by	Date Authorised
1.0	Initial report (first draft).	RS	02/02/2021
1.1	Report updated to address feedback from NGET	RS	17/02/2021
1.2	Report updated to address feedback from NGET	RS	03/03/2021

Contents

Work Package Key

WP1	Generation	Digital Engineering Ltd
WP2	Cities	Cardiff University
WP3	Electricity network	Burns & McDonnell
WP4	Transport	BMT Global
WP5	Industry	CR Plus
WP6	Socio-economic	Arup
WP7	Optimisation	Arup
WP8	Communications	National Grid Electricity Transmission
WP9	Hydrogen and CO_2 infrastructure	Progressive Energy
WP10	Scenario development	Regen
WP11	Pathfinder	Progressive Energy

Executive Summary

This document outlines the processing that Digital Engineering (DE) has applied, within the Zero2050 South Wales project, to various demand data provided by other project partners. Hereafter, DE will be referred to as WP1 (aka Work Package 1 – Generation).

The demand data provided to WP1 by other WPs is summarised in the table below:

Demand type	Source
Heating (domestic and non-domestic)	WP2
Buses	WP2
Passenger electric vehicles	WP2 & WP4
HGV, Rail, Shipping, Aviation	WP4
Industry	WP5
Non-heating electricity demand	WP2

In general, WP1's aim was to process each of the demand data sources in such a way as to provide data at Local Authority District (LAD) level, in kWh per hour for the following:

- One 'baseline' year (2018)
- Three future years (i.e. 2030, 2040 and 2050)
- Three socio-economic scenarios:
    - Current Trends
    - Green-Industrial Growth
    - Service-Led Growth
- Different fuel types (e.g. electricity, hydrogen, ammonia)
- Different technological scenarios (e.g. high electrification, high hydrogen)

Tables summarising the total annual and peak hourly demand for each demand source, each future year and various scenarios are provided in Appendix A and Appendix B.

In addition to the work outlined in this document, the processed demand data has been shared with project partners using the project Sharepoint drive and communicated to other WPs and wider project stakeholders. Please note that demand data was uploaded as negative numbers, as requested by WP7.

1 Domestic and Non-Domestic Heating Demand

Data was provided by Cardiff University (WP2) at substation-level within Cardiff, Swansea, Newport. It was also provided for two 'technological' scenarios:

- 'Electrification' (i.e. high electrification)
- 'Hydrogen' (i.e. high hydrogen)

And for two of the socio-economic scenarios:

- Current Trends (aka BAU)
- Green Industrial Growth (this data was also used for the Service Led Growth scenario)

WP1 provided heating demand as thermal and electrical demand, for the technological and socio-economic scenarios outlined above. This data allowed WP7's optimiser to determine the optimal mix of heating technology. WP1 was required to add demand for backup heaters (also provided by WP2) to this thermal demand. Backup heaters operate during periods of very cold weather when heat pumps can no longer operate.

1.1 1-in-20 Year Peak Heating Demand

As the only source of demand considered as weather-dependent[1], demand for heating was the only source that considered the impact of a 1-in-20 year winter cold event. WP2 used an assumed daily-average temperature value of -4.2 °C[2] as an input to its demand model on the second Wednesday of each future year (i.e. 2030/2040/2050). This ensured that the 1-in-20 year peak heat demand value was not artificially lowered by modelling the demand on a weekend (when demand is typically lower than during the week).

WP1 was required to deliver the year of heating demand, with and without the inclusion of the 1-in-20-year peak heating demand, to WP7.

[1] Other demand sources (such as battery electric vehicles) were recognised to be somewhat weather-dependent but with only a small impact on overall demand
[2] Based on a composite weather variable value assumed by gas utilities in the UK

1.2 Aggregation Method

WP1 worked closely with NGET to process domestic and non-domestic heating demand. Many different steps were followed, with different approaches required for electricity and thermal demand, domestic and non-domestic demand, and the inclusion or exclusion of EPC efficiency improvements within different dwelling types. An overview of these steps is provided below:

1) Estimate housing numbers in different years (2030, 2040, 2050) for each LAD in South Wales, and split into different dwelling types (e.g. Flat, Detached, Terraced). (1) (2)
2) Use annual heat demand per dwelling type from WP2, and the housing numbers from 1) to calculate total annual domestic demand per LAD for 2030/2040/2050.
3) Split non-domestic heat demand for South Wales provided by WP10 (3) to LAD-level based on data from Institute of Welsh Affairs (4).
4) Scale Cardiff domestic and non-domestic heat demand profile (as provided by WP2) in 2030, 2040, 2050 by the total domestic demand in each of the other LADs from 2).
5) Combine domestic and non-domestic profiles and add consideration of backup heating.

The exact steps required to process this data, and the associated validation of these steps, are contained within a separate spreadsheet (5). Please note that all demand was provided as negative values as requested by WP7.

1.3 Key Assumptions/References

Table 1: Census 2011 - number of households by accommodation type (1)

Local Authority	Detached	Semi-Detached	Terraced	Flats/ Apartments	Total Houses
Blaenau Gwent	3409	8349	15749	2885	30392
Bridgend	13873	23007	15401	6129	58410
Caerphilly	12130	29617	26526	6180	74453
Cardiff	19644	41871	43632	37328	142475
Carmarthenshire	30838	26549	15438	5639	78464
Merthyr Tydfil	3813	6907	12020	1498	24238
Monmouthshire	16898	11005	6515	3714	38132
Neath Port Talbot	12143	26143	15842	6193	60321
Newport	11560	18905	20267	10287	61019
Pembrokeshire	22535	14458	10095	5577	52665
Rhondda Cynon Taf	14963	27264	49324	7977	99528
Swansea	24203	35097	27433	16531	103264
Torfaen	6962	10594	16359	4548	38463
Vale of Glamorgan	14340	16659	14490	7731	53220

Table 2: Projections of numbers of households per LAD (2)

Local Authority	2018	2025	2030	2040	2050
Blaenau Gwent	31074	31481	31541	31823	32259
Bridgend	61842	64653	66133	68460	70473
Caerphilly	76658	78401	78955	79894	81006
Cardiff	153204	160745	165277	171607	175935
Carmarthenshire	81505	83331	84084	85077	86147
Merthyr Tydfil	24869	25380	25543	25821	26169
Monmouthshire	40114	41112	41493	41819	41949
Neath Port Talbot	62054	63526	64310	65524	66632
Newport	65157	69152	71398	75358	79193
Pembrokeshire	55618	57406	58003	58643	59313
Rhondda Cynon Taf	104865	109560	112183	116841	121497
Swansea	108874	113773	116776	121518	125946
Torfaen	39958	411512	41698	42643	43497
Vale of Glamorgan	57230	60648	62423	64926	67108

2 Bus Demand

Demand for buses was provided by WP2 within Cardiff, Swansea, and Newport. The data was provided for two technological scenarios: hydrogen and electrification. However, DE was only required to process the data for the electrification scenario.

Demand was provided for three different fuel types (all in a unit of kW):

- Electricity
- Hydrogen
- Biogas

Demand for buses was assumed to be the same across all socio-economic scenarios[3].

2.1 Aggregation Method

No aggregation was required for bus demand. Demand was provided per LAD by WP2 for Cardiff, Swansea and Newport. DE simply ensured that the demand was hourly and in kWh, and negative as requested by WP7. Bus demand for the remaining 11 LADs was included in the HGV data generated by WP4.

2.2 Key Assumptions/References

None required.

[3] Assumption made by WP2 due to the relatively small overall demand for buses compared to EVs and heating

3 Passenger Electric Vehicle Demand

Electric vehicle demand was provided by:

- Cardiff University (WP2): substation-level data within Cardiff, Swansea, Newport
- BMT Global (WP4): lad-level data for the other 11 LADs in South Wales

This data was provided for two socio-economic scenarios:

- Low growth (Current Trends)
- High growth (Green Industrial Growth and Service Led Growth)

3.1 Aggregation Method

Electric vehicle data was provided by two different project partners and each required slightly different processing approaches:

- Substation-level data from WP2 was aggregated to LAD-level, then converted to hourly kWh values (as required by WP7)
    - half-hourly kW data was converted to kWh before summing over an hour
- LAD-level data from WP4 was converted to hourly kWh values (as required by WP7)
    - half-hourly MW data was converted to kWh then summed over an hour

The processed data (from both WP2 and WP4) was merged to produce a file per scenario and year containing all 14 LADs in South Wales. Please note that all demand was provided as negative values as requested by WP7.

3.2 Key Assumptions/References

None

4 HGV, Rail, Shipping, Aviation Demand

Demand for HGVs, rail, shipping and aviation were all provided by WP4 per LAD. HGV and rail data was provided as half-hourly data, but shipping and aviation were provided as an annual total demand. In order to provide data to WP7 in the required format (i.e. hourly data in kWh), WP1 assumed a constant demand profile across the year[4] for shipping and aviation.

A summary of the demand sources and associated fuel types are provided in the table below:

Table 3: HGV, rail, shipping and aviation demand fuel types and unit conversions

Fuel		Unit provided	Assumed energy density
Heavy Goods Vehicles (HGVs)	Electricity	MW	N/A
	Hydrogen	kg/30min	120.24 MJ/kg (6)
	Compressed Natural Gas (CNG) / Liquefied Natural Gas (LNG)	kg/30min	50.04 MJ/kg (6)
Rail	Electricity	MW	N/A
	Hydrogen	kg/30min	120.24 MJ/kg (6)
Shipping	Heavy Fuel Oil (HFO) / Low Sulphur Fuel Oil (LSFO) / Marine Gasoil (MGO)	tonnes/year	41.20 MJ/kg (6)
	Liquefied Natural Gas (LNG)	tonnes/year	50.04 MJ/kg (6)
	Electricity	MW	N/A
	Ammonia	tonnes/year	18.61 MJ/kg (6)
Aviation	Jet A1 Aviation Fuel	tonnes/year	42.80 MJ/kg (6)
	Sustainable Aviation Fuel	tonnes/year	42.80 MJ/kg (6) (7)

4.1 Aggregation Method

- Unit conversion as per Table 3
  - MJ/kg values converted to kWh/kg (i.e. divided by 3.6) and summed over each hour
- Conversion of shipping and aviation demand to time series (using a constant demand profile)

Please note that all demand was provided as negative values as requested by WP7.

4.2 Key Assumptions/References

Non-electricity demand was provided by WP4 in kg or tonnes (see Table 3 above). WP1 was required to provide demand to WP7 in kWh to align with other demand sources. In these cases, WP1 converted the kg/tonnes figures to kWh assuming energy density values as recommended by WP4, based on literature (6) (7)

[4] As suggested by project partners

5 Industrial Demand

Data was provided by CR Plus (WP5) for all industry in South Wales. This was due to confidentiality concerns, as several large sites would have made up the bulk of demand in several LADs. The data was provided for three technological scenarios: Electrification, Hydrogen and 'Plausible'. Over the course of the project DE processed data from all three scenarios. At the time of writing, the Plausible scenario was requested by WP7, and WP3 had previously required data from the Electrification and Hydrogen scenarios. DE also processed industrial demand at different connection levels (corresponding to transmission-connected and distribution network connected demand) as required by WP3.

The data was split into electricity, hydrogen and natural gas demand[5]. WP1 had also processed demand for 'any thermal vector' during previous rounds of processing but this is not described in detail here. A further adjustment to the demand from WP5 was applied based on recommendations from WP6 and WP7. The following % changes were applied to WP5's demand to align the data to socio-economic scenarios defined by WP6:

Table 4: Manipulations to industrial demand projections, as requested by WP6

Year	Business as Usual	Green-Industrial Growth	Service-Led Growth	Application
2030	83 %	108 %	92 %	Applied to WP5's 2030 demand projection
2040	67 %	117 %	83%	Applied to WP5's 2040 demand projection
2050	50 %	125 %	75 %	Applied to WP5's 2050 demand projection

5.1 Aggregation Method

Demand was dis-aggregated from all South Wales to LAD-level, based on BEIS 2017 energy consumption data (8). The split was based on LAD-level industrial & commercial electricity and gas consumption from BEIS, and summarised as a percentage 'weight' (see Table 5).

A timestamp correction was applied to account for the fact that industrial demand projections use 2018 timestamps (e.g. 7th January was a Sunday with correspondingly lower levels of demand). This correction is described below:

[5] Natural gas was used in 2030 and 2040 as the system progressed towards hydrogen. The rate of progression was modelled as linear as suggested by NGET and WP5.

- WP5 produced hourly data based on a repeated weekly profile within a given time period (either seasonally or monthly), with each weekday consistent with the same weekday in each week of that period.
    - For electricity demand, WP5 produced data based on distinct summer & winter profiles, each weekday was consistent within each season.
    - For hydrogen (and natural gas) demand, WP5 produced data based on distinct monthly profiles, each weekday was consistent within each month.
    - For each output year (2030/2040/2050) the correction aligned each weekday profile from each time period within 2018 with its corresponding weekday and period within the output year. This ensured that, for example, industrial demand on a Saturday aligned with Domestic demand on a Saturday.

Please note that all demand was provided as negative values as requested by WP7.

5.2 Key Assumptions/References

Table 5: Industrial & commercial energy consumption in 2017 (8)

LA Code	Government Office Regions and LAU1 Areas	Industrial & Commercial – Gas (GWh)	Gas 'weight'	Industrial & Commercial – Electricity (GWh)	Electricity 'weight'
W06000019	Blaenau Gwent	205.3	3%	160.4	2%
W06000013	Bridgend	503.0	8%	398.6	6%
W06000018	Caerphilly	297.9	5%	433.1	6%
W06000015	Cardiff	1200.4	19%	1042.3	15%
W06000010	Carmarthenshire	393.3	6%	576.5	8%
W06000024	Merthyr Tydfil	201.9	3%	120.2	2%
W06000021	Monmouthshire	309.5	5%	238.4	3%
W06000012	Neath Port Talbot	346.6	5%	1169.4	17%
W06000022	Newport	728.3	11%	618.8	9%
W06000009	Pembrokeshire	164.9	3%	730.2	10%
W06000016	Rhondda Cynon Taf	533.8	8%	430.0	6%
W06000011	Swansea	1007.2	16%	547.6	8%
W06000020	Torfaen	338.4	5%	273.8	4%
W06000014	Vale of Glamorgan	222.7	3%	308.1	4%

6 Non-Heating Electricity Demand

The following approach was adopted due to a lack of available data for electricity demand excluding heating and industry.

Data for the 14 LADs in South Wales was provided by NGET and WP2 in the form of hourly electricity demand in 2018. This information was based on national demand data published by National Grid Electricity System Operator (NG ESO), scaled to each LAD in South Wales using annual electricity demand in 2018 published by BEIS (8). Industrial demand (based on WP5's data) per LAD had also been excluded by NGET from these profiles.

WP1 then subtracted the electricity demand for heating from these profiles to give an indication of the non-heating electricity demand per LAD in South Wales for 2018. This demand was assumed to remain constant through 2030, 2040 and 2050.

Please note that all demand was provided as negative values as requested by WP7. The peak and total annual non-heating electricity demand in 2018 is provided in Table 6 below:

Table 6: Non-heating annual and peak electricity demand

Year: 2018	Total electricity demand (TWh)	Electricity peak demand (GW)
Non-heating electricity demand	-4.80	-1.13

Appendix A Aggregated Demand: Per Demand Source

1) Blank fields are due to data not required to be produced for WP7 - Optimisation.
2) Two types of peaks are included for heating, one peak from the representative year temperature and 1-in-20 peak (at -4.2°C)
3) Industry demand is based on the Plausible scenario produced by WP5 - CR+
4) Total thermal demand for heating was provided to WP7, and therefore hydrogen demand for heating is not included in the following tables (see) cells with *). Total thermal demand represented the demand supplied by both electricity and hydrogen technologies.

Table 7: Demand per demand source - Current Trends: 2030

Current Trends: 2030	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.002	0.000		0.000	0.000	
Cars	-1.077	-0.273				
Heating - Electrification - withEPC	-2.797	-1.306	-1.783	*	*	*
Heating - Hydrogen - withEPC	-1.345	-0.607	-0.738	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.039	-0.010		-0.046	-0.011	
Industry	-4.465	-0.624		-0.950	-0.169	
Rail	-0.013	-0.003		-0.002	0.000	
Shipping	-0.039	-0.004				

Table 8: Demand per demand source - Current Trends: 2040

Current Trends: 2040	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.015	-0.004		-0.003	-0.001	
Cars	-3.439	-0.872				
Heating - Electrification - withEPC	-3.235	-1.517	-1.949	*	*	*
Heating - Hydrogen - withEPC	-1.089	-0.501	-0.625	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.153	-0.038		-0.324	-0.080	
Industry	-4.646	-0.638		-2.226	-0.397	
Rail	-0.030	-0.006		-0.006	-0.001	
Shipping	-0.0890	-0.0102				

Table 9: Demand per demand source - Current Trends: 2050

Current Trends: 2050	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.056	-0.015		-0.025	-0.007	
Cars	-3.795	-0.962				
Heating - Electrification - withEPC	-3.534	-1.687	-2.024	*	*	*
Heating - Hydrogen - withEPC	-0.849	-0.461	-0.524	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.346	-0.085		-1.412	-0.348	
Industry	-4.374	-0.575		-2.721	-0.485	
Rail	-0.082	-0.016		-0.007	-0.001	
Shipping	-0.140	-0.016				

Table 10: Demand per demand source - Service Led Growth: 2030

Service Led Growth: 2030	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.002	0.000		0.000	0.000	
Cars	-1.159	-0.294				
Heating - Electrification - withEPC	-2.822	-1.319	-1.800	*	*	*
Heating - Hydrogen - withEPC	-1.371	-0.621	-0.755	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.041	-0.010		-0.048	-0.012	
Industry	-4.949	-0.692		-1.053	-0.187	
Rail	-0.016	-0.003		-0.003	0.000	
Shipping	-0.040	-0.005				

Table 11: Demand per demand source - Service Led Growth: 2040

Service Led Growth: 2040	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.015	-0.004		-0.003	-0.001	
Cars	-3.693	-0.935				
Heating - Electrification - withEPC	-3.272	-1.539	-1.978	*	*	*
Heating - Hydrogen - withEPC	-1.121	-0.519	-0.648	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.163	-0.040		-0.344	-0.085	
Industry	-5.756	-0.791		-2.757	-0.491	
Rail	-0.039	-0.008		-0.008	-0.002	
Shipping	-0.093	-0.011				

Table 12: Demand per demand source - Service Led Growth: 2050

Service Led Growth: 2050	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.056	-0.015		-0.025	-0.007	
Cars	-4.077	-1.033				
Heating - Electrification - withEPC	-3.576	-1.721	-2.062	*	*	*
Heating - Hydrogen - withEPC	-0.875	-0.482	-0.548	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.374	-0.092		-1.527	-0.377	
Industry	-6.561	-0.863		-4.081	-0.728	
Rail	-0.111	-0.022		-0.009	-0.002	
Shipping	-0.150	-0.017				

Table 13: Demand per demand source - Green Industrial Growth: 2030

Green Industrial Growth: 2030	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.002	0.000		0.000	0.000	
Cars	-1.159	-0.294				
Heating - Electrification - withEPC	-2.822	-1.319	-1.800	*	*	*
Heating - Hydrogen - withEPC	-1.371	-0.621	-0.755	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.041	-0.010		-0.048	-0.012	
Industry	-5.809	-0.812		-1.236	-0.220	
Rail	-0.016	-0.003		-0.003	0.000	
Shipping	-0.040	-0.005				

Table 14: Demand per demand source - Green Industrial Growth: 2040

Green Industrial Growth: 2040	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.015	-0.004		-0.003	-0.001	
Cars	-3.693	-0.935				
Heating - Electrification - withEPC	-3.272	-1.539	-1.978	*	*	*
Heating - Hydrogen - withEPC	-1.121	-0.519	-0.648	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.163	-0.040		-0.344	-0.085	
Industry	-8.113	-1.114		-3.887	-0.693	
Rail	-0.039	-0.008		-0.008	-0.002	
Shipping	-0.093	-0.011				

Table 15: Demand per demand source - Green Industrial Growth: 2050

Green Industrial Growth: 2050	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)	Hydrogen: typical year (TWh)	Hydrogen: peak (GW)	Hydrogen 1-in-20: peak (GW)
Aviation						
Buses	-0.056	-0.015		-0.025	-0.007	
Cars	-4.077	-1.033				
Heating - Electrification - withEPC	-3.576	-1.721	-2.062	*	*	*
Heating - Hydrogen - withEPC	-0.875	-0.482	-0.548	*	*	*
Heating - Electrification - withoutEPC				*	*	*
Heating - Hydrogen - withoutEPC				*	*	*
Hgvs	-0.374	-0.092		-1.527	-0.377	
Industry	-10.935	-1.438		-6.802	-1.213	
Rail	-0.111	-0.022		-0.009	-0.002	
Shipping	-0.150	-0.017				

Appendix B Aggregated Demand: Totals

Please note that the table below only contains total electricity demand. Hydrogen demand was not provided as a separate demand fuel by WP2, and therefore could not be aggregated in the same way as electricity.

Table 16: Aggregated South Wales electricity demand

Socio-economic scenario	Year	Heating scenario	Electricity: typical year (TWh)	Electricity: peak (GW)	Electricity 1-in-20: peak (GW)
CT	2030	Electrification: with EPC	-13.243	-2.918	-3.340
		Hydrogen: with EPC	-11.791	-2.244	-2.359
GIG	2030	Electrification: with EPC	-14.699	-3.108	-3.533
		Hydrogen: with EPC	-13.248	-2.408	-2.552
SLG	2030	Electrification: with EPC	-13.839	-3.006	-3.431
		Hydrogen: with EPC	-12.388	-2.323	-2.450
CT	2040	Electrification: with EPC	-16.417	-3.619	-4.077
		Hydrogen: with EPC	-14.272	-2.768	-2.853
GIG	2040	Electrification: with EPC	-20.199	-4.113	-4.577
		Hydrogen: with EPC	-18.047	-3.261	-3.349
SLG	2040	Electrification: with EPC	-17.841	-3.827	-4.294
		Hydrogen: with EPC	-15.689	-2.978	-3.066
CT	2050	Electrification: with EPC	-17.135	-4.006	-4.260
		Hydrogen: with EPC	-14.450	-2.810	-2.875
GIG	2050	Electrification: with EPC	-24.089	-4.943	-5.208
		Hydrogen: with EPC	-21.387	-3.716	-3.812
SLG	2050	Electrification: with EPC	-19.715	-4.392	-4.645
		Hydrogen: with EPC	-17.013	-3.165	-3.249

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