InStaFlex
D1.2 Overview Deferrable Loads

Submitted to: FOD Economy
Lead Partner: PropheSea

Instaflex Project – Results Report

1. Project Information

Project Title	InStaFlex
Client	FOD Economy
Lead Partner Report	PropheSea
Partner Organisations	University of Antwerp, Royal Meteorological Institute, Oktow, PropheSea

2. Document Version History

Version	Date	Author(s)	Description / Changes
0	20/03/2025	Tomas Van Oyen	Presentation format
1	02/04/2025	Tomas Van Oyen	Confluence text
2	18/06/2025	Tomas Van Oyen	Document sent out to the consortium for comments
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3. Executive Summary

This report presents the findings of our investigation into the types of assets available for steering within energy systems and how these can be abstracted into model-relevant categories. The objective was to build a foundational understanding that supports the development of robust, scalable models for asset control and optimization.

Our analysis was based on three complementary sources:

1. **Interviews with potential clients** – These discussions provided practical insights into real-world asset configurations, current steering capabilities, operational constraints, and business priorities.
2. **Literature review** – We explored academic and industry publications to identify common asset classifications, control methodologies, and abstraction frameworks already in use or proposed.
3. **Feedback on presentations** – Input received during stakeholder presentations helped validate our assumptions, identify gaps, and refine our categorization approach.

The investigation revealed a diverse landscape of steerable assets, ranging from HVAC systems, EV chargers, and industrial cooling installations, to battery storage and flexible production processes. Despite this diversity, clear patterns emerged that enabled the abstraction of assets into a manageable number of functional groups based on controllability, temporal flexibility, energy intensity, and role within the broader system (e.g., consumption vs. storage).

These asset groupings will serve as the basis for developing generalized control models, enabling more efficient simulation, forecasting, and optimization of energy systems across sectors.

4. Key Results

4.1 Overall types

Overall, we delineate overall 5 distinct types of industrial assets:

	What	Characteristics
1/	Source	Asset that produces energy.
2/	Sink	Asset that consumes energy and cannot be steered.
3/	Storage	Asset that can store energy to be consumed later.
4/	Demand side management	Asset that consumes energy and of which the consumption can be steered; within user-provided operational.
5/	Converter	Asset that converts a energy source (e.g. gas, electricity, ..) into energy (electrical and heat).
6/	Grid	Representation of the economic (ecologic) constraints to be optimized.

In order to couple these assets with an optimization methodology - in a meaningful way - we added to this list also a component that represents the economic (and possibly ecological) boundary conditions that provide a suitable cost.

4.2 Translation to (sub)components and relation with industrial assets (examples)

Each of these types relates to various (industrial) assets with different characteristics and necessary information. Herebelow, we provide an overview of encountered energy related industrial assets in relation to the types introduced above:

Type	Component	Example / comments	Forecast/modelling method

Source	PV (photo voltaic) energy source	pv-installation	forecasting by combining whitebox methods with data
	Wind energy source	wind-turbine installation	forecasting by combing whitebox methods with data
	CHP	CHP installation	forecasting by whitebox modelling
Sink	Power	general power consumption within an industrial site which cannot be deferred as load; e.g. user power consumption	forecasting by black-box time series algorithms
	Heat	general heat consumption within an industrial site which cannot be deferred as load; e.g. user heat consumption	forecasting by black-box time series algorithms
Storage	Power	battery	defined by max. (dis)charge, capacity and efficiency
	Heat	heat buffer	defined by max. (dis)charge, capacity, thermal efficiency and inertia
Demand side management	Power - fully manageable	Electrically vehicles	defined by capacity, requested volume, and time to charge
	Power - fixed profile	Metal shredding machine	defined by power consumption profile;

			and time window to shift
	Heat - fully manageable	location to cool/warm and the temperature can change over a certain region	defined by min/max temperature and possible temperature buffer
	Heat - fixed profile	a blancer	
	Biological - fully manageable	Waste water treatment	*experimental* component where the waste water treatment process is dynamically controlled in relation to energy prices
Converter	Power to heat	e-boiler	
Grid	Low Voltage connection		
	Mid Voltage connection		
	High Voltage connection		
	Fixed electrically contract		
	Dynamic contract		
	Pass through contract		
	Revenue through Frequency Reserve Containment		

4.3 Connecting the components and necessary data

Only defining each component does not suffice to optimally control the energy flow with respect to external (economic) boundary conditions. We need to add connections between the defined components and account for the cost and inefficiencies for each flow. Also we introduce a node connection (for power and heat) at which the incoming flows need to match with the outgoing flows.

Figure 1 Impression of our system Fore-sight that allows to introduce various components and connections between them.

We developed a system that allows for a certain location to define the various components and establish connections between them; see Figure 1. For each component, we define the following necessary connections and related available *data points*:

Component	Local connection	Non-local connection
Energy Source (PV and Wind)		<u>*component -> node:*</u> - active-power-measured - active-power-measured-setpoint - active-power-forecast - active-power-setpoint

Sink		*node -> component:* - active-power-measured - active-power-forecast
Storage	energy-soc-measured energy-soc-forecast	*component -> node:* - active-power-measured - active-power-measured-setpoint - active-power-forecast - active-power-setpoint *node -> component:* - active-power-measured - active-power-measured-setpoint - active-power-forecast - active-power-setpoint
EnergyDSM	energy-soc-measured energy-soc-forecast	*component -> node:* - active-power-measured - active-power-measured-setpoint - active-power-forecast active-power-setpoint
TempDSM	reference-air-measured reference-air-setpoint reference-air-measured-setpoint reference-air-forecast	*node → component:* active-power-measured active-power-measured-setpoint active-power-forecast active-power-setpoint

The physical information that is necessary in order start modelling certain components is provided here below:

Component	Information
PV	-. number of panels
	-. max power of one panel
	-. max power of the system
	-. orientation
	-. tilt
	-. number of inverters
	-. kWp
	-. if there is shading to account for
Battery	-. maximum charging power
	-. maximum discharging power
	-. capacity
	-. cycle life
	-. efficiency on charging
	-. efficiency on discharging
	-. state of charge maximum
	-. state of charge minimum
Electrical Vehicles	-. number of stations
	-. station number - flexible
	-. station number - if the user can choose
	-. station number maximum charging

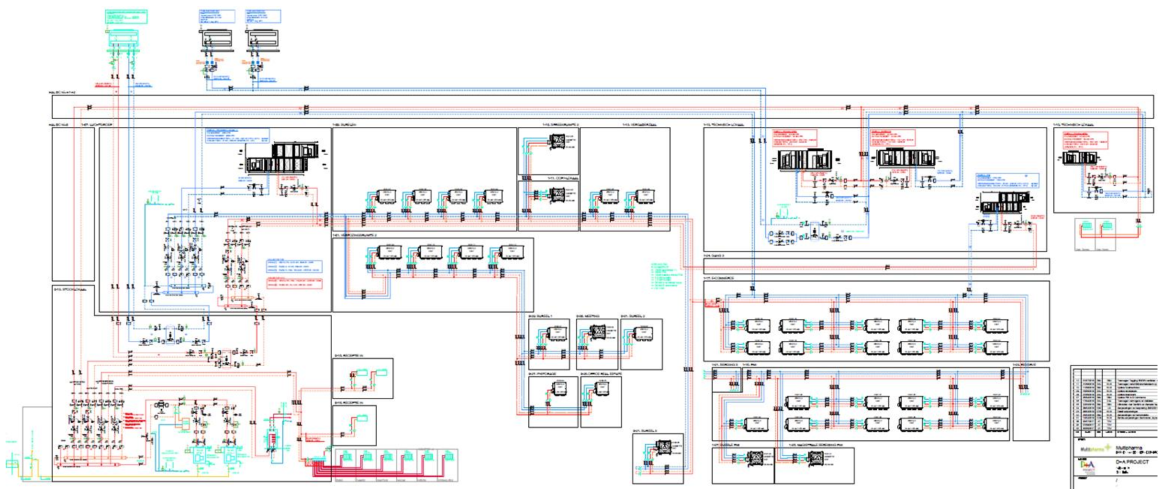
	-. flexible charging coefficient: describes the factor of the amount of time that a user needs to provide to allow flexible charging e.g. the user has 4 hours and maximum power charge/discharge is 11 kW ; a factor 2 means that for flexible charging the maximum energy to charge is 22kWh
Energy Grid	-. supplier factor -. supplier supplement -. supplier green energy taxes -. supplier CHP taxes -. supplier subscription -. distribution supplement -. distribution extra taxes -. distribution special taxes -. distribution subscription -. distribution energy fund -. distribution capacity tariff -. distribution capacity period

Case 04

Case 04 has been agreed upon by the consortium as first subject for detailed modelling. As described in WP2, one of the challenges Oktow faces is the confidentiality requirements of many clients regarding sensitive data. Hence the name of the Oktow client is not mentioned in this report, but is reffered to as Case 04.

Case 04 regards a distribution center of pharmaceuticals. It consists of an office building with a distribution center for farmaceutical products. The building is climatised with a hybrid HVAC system, consisting of heat pumps and gas boilers. The main distribution system in the building is based on the air handling units, both providing ventilation and heating and cooling to the storage, packaging and distribution zones. A more detailed description can be found in report 2.1.

This case has been selected as it is a site where a lot of different data points are available. As is mentioned in report 2.1, having a broad scope of datapoints available is not guaranteed in standard monitoring projects. In dataset 04, a lot of electrical and thermal energy streams are measured, alongside a lot of thermal measurements troughout the installation and the building itself. This broad scope of available data was deemed a valuable starting point for UA and Prophesea.



In cooperation with the client, Oktow obtained the HVAC P&ID, serving as imput for the simulation model. Alongside this P&ID, Oktow monitors several internal energy vectors. This data has been extracted and made available to the research partners.

Type meter	**ODP Meternr.**	**Extra info**
Gas meting	G2	Hoofdmeting, Meter fluvius
Elek meter	E1	LG1, Picking Area, Puls vent
Elek meter	E2	LG1, Picking Area, Extr vent
Elek meter	E3	LG2, Picking Area, Puls vent
Elek meter	E4	LG2, Picking Area, Extr vent
Elek meter	E5	LG3, Burelen, Puls vent

Elek meter	E6	LG3, Burelen, Extr vent
Elek meter	E7	LG4, Expeditie, Puls vent
Elek meter	E8	LG4, Expeditie, Extr vent
Elek meter	E9	LG5, PMI, Puls vent
Elek meter	E10	LG5, PMI, Extr vent
Elek meter	E11	ALSB Nood
Elek meter	E12	WP (KM3)
Elek meter	E13	Aankomst Transfo 1
Elek meter	E14	PV (zuid, 10kWp)
Elek meter	E32	Aankomst Transfo 2
Elek meter	E33	AMR meter Fluvius
Elek meter	E46	EB Laders
Elek meter	E47	25F2 : Container 1
Elek meter	E48	25F3 : Compressor 1
Elek meter	E49	25F4 : Compressor 2
Elek meter	E52	7Q1 : KM1
Elek meter	E53	8Q1 : KM2
Elek meter	E54	9F3 : elektrisch bord HVAC 1
Elek meter	E55	9F4 : frigo
Elek meter	E56	9F5 : Condensor 1
Elek meter	E57	9F6 : Condensor 2
Elek meter	E58	9F7 : Diepvries
Elek meter	E59	Opbrengst PV (OW - 680kWp)

Calori meter	C3	Warm water, Collector 1 Stooklokaal, rad+luchverhitter
Calori meter	C4	Warm water, Collector 1 Stooklokaal, SWW
Calori meter	C5	Warm water, Collector 2 Techn lokaal V2, Ventilo's + PMI
Calori meter	C6	Warm water, Collector 2 Techn lokaal V2, LG5/3
Calori meter	C7	Ijs water, Collector 3 Techn lokaal V2, Ventilo's
Calori meter	C8	Ijs water, Collector 3 Techn lokaal V2, LG3
Calori meter	C9	Ijs water, Collector 3 Techn lokaal V2, LG5
Temperatuur	T1	Pulsie LG1, Picking Area
Temperatuur	T2	Pulsie LG2, Picking Area
Temperatuur	T3	Pulsie LG3, Burelen
Temperatuur	T4	Pulsie LG4, Expeditie
Temperatuur	T5	Pulsie LG5, PMI
Temperatuur	T6	Ruimtevoeler zone 1 laag, Picking Area_LG1
Temperatuur	T7	Ruimtevoeler zone 1 midden, Picking Area_LG1
Temperatuur	T8	Ruimtevoeler zone 1 hoog, Picking Area_LG1
Temperatuur	T9	Ruimtevoeler zone 2 laag, Picking Area_LG1
Temperatuur	T10	Ruimtevoeler zone 2 midden, Picking Area_LG1

Temperatuur	T11	Ruimtevoeler zone 2 hoog, Picking Area_LG1
Temperatuur	T12	Ruimtevoeler referentie Burelen_Bureel 1
Temperatuur	T13	Ruimtevoeler referentie Expeditie
Temperatuur	T14	Ruimtevoeler referentie PMI_1
Temperatuur	T15	Vertrek temp WP ijs water__KM_PrimaireTempToevoer
Temperatuur	T16	Buffer vat ijswater machines Picking Area
Temperatuur	T17	Vertrek temp CV ketels samen
Temperatuur	T18	Vertrek temp CV ketel 1
Temperatuur	T19	Vertrek temp CV ketel 2
Temperatuur	T20	Vertrek temp WP warm water
Temperatuur	T21	Vertrek temp WP ijs water
Temperatuur	T22	Buffer vat WP + CV warm water
Temperatuur	T23	Buffer vat WP ijs water_Temp ijswater buffervat aan WP
Temperatuur	T24	Vertrek temp, Warm water, Collector 1 Stooklokaal, LG4/2/1_Vertrektemperatuur bij LG1

Temperatuur	T25	Vertrek temp, Warm water, Collector 1 Stooklokaal, Buffervat Collector 2
Temperatuur	T26	Vertrek temp, Warm water, Collector 1 Stooklokaal, rad+luchverhitter_Vertrektemperatu radiatoren
Temperatuur	T27	Buffervat, Warm water, Collector 1 Stooklokaal, SWW_Sanitair warm water Vat temp
Temperatuur	T28	Vertrek temp, Warm water, Collector 2 Techn lokaal V2, Ventilo's + PMI_Vertrektempera
Temperatuur	T29	Vertrek temp, Warm water, Collector 2 Techn lokaal V2, LG5/3_Vertrektemperatuur KRIN
Temperatuur	T30	Vertrek temp, Ijs water, Collector 3 Techn lokaal V2, Ventilo's_RETOUR [vertrek geen goe
Temperatuur	T31	Vertrek temp, Ijs water, Collector 3 Techn lokaal V2, LG3_RETOUR [vertrek geen goeie wa
Temperatuur	T32	Vertrek temp, Ijs water, Collector 3 Techn lokaal V2, LG5_RETOUR [vertrek geen goeie wa

The data points are standard measured every 15 minutes. As not all datapoints were available for more than a year, an export has been made and shared from beginning of june 2024 until 26/02/2025.

5. Contact and Acknowledgements:

Organisation	Contact Person	Email
PropheSea	Tomas Van Oyen	tomas.vanoyen@prophesea.eu
Oktow	Brecht Zwaenepoel	brecht@oktow.be

University of Antwerp	Peter Hellinckx	peter.hellinckx@uantwerpen.be
Royal Meteorological Institute	Joris Van den Bergh	joris.vandenbergh@meteo.be