A CASE STUDY OF RENEWABLE HYDROGEN INTEGRATION IN A REFINERY FRAMEWORK

Catedra MOEVE – University of Seville

Pietro Sidoli

Chemical and Environmental Engineering Department. Escuela Técnica Superior de Ingeniería,

Universidad de Sevilla. Camino de los Descubrimientos s/n. 41092 Seville, Spain

psidoli@us.es

H2 Summit 2026 | Fota Island Resort, Cork | 19 November 2026

2050 DECARBONIZATION ROADMAP

❑ **Directive RED III:**

Production of re

> 42% l

>60% b

Transport Fuel Ta

of total fuels:

> 5.5 %

❑ **ReFuelEU Av**

- 1.2% b
- 5% by 2
- 10% by 2040
- 35% by 2050.

REFINERY GREEN H2 PRODUCTION





❑ **EU ETS**: A unified benchmark for hydrogen production has been extended to the refining sector.

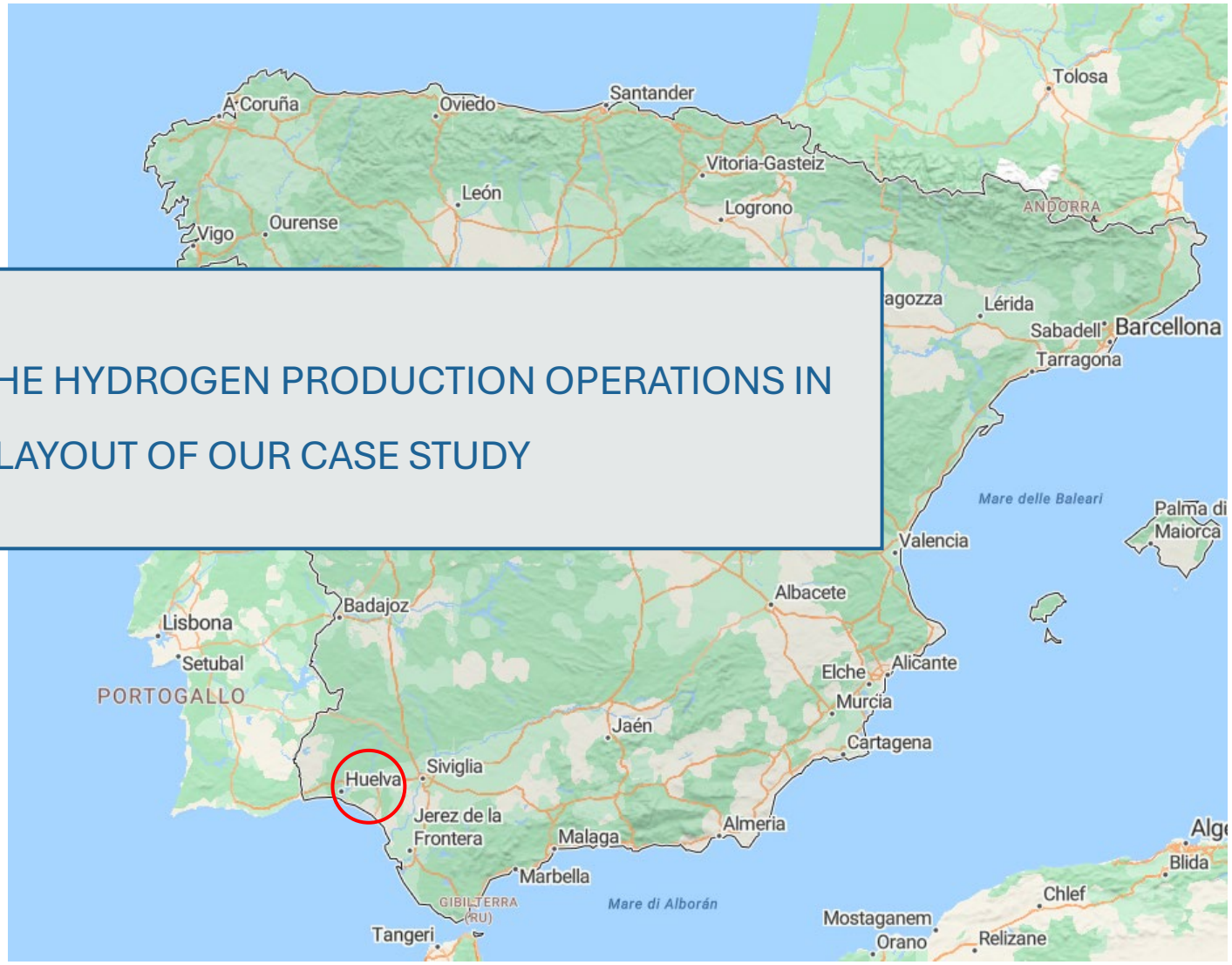
CASE STUDY

SPAIN Energy Park: La Rábida, led by Moeve.

Why : active collaboration, project ONUBA



SCOPE: DEFINE & OPTIMIZE THE HYDROGEN PRODUCTION OPERATIONS IN THE FUTURE LAYOUT OF OUR CASE STUDY



THE PROJECT CHALLENGES

- ❑ The integration of newly planned processing units into the existing refinery layout.
- ❑ The intermittency and volatility of renewable power supply,
- ❑ Market volatility across electricity, natural gas, and carbon certificate pricing.

All these variables must be systematically evaluated against the fluctuating operating conditions of the downstream consumer units.

FIRST STEP:

Model the actual hydrogen grid to establish the profile of net hydrogen demand.

→ Building base for future integration and optimization during transition between actual grey and green hydrogen production

PROCEDURE

Units in H2 grid:

3 Major consumers **3 Major producers** **2 Purification unit** **5 Auxiliary/minor consumers**

Pre-flight procedure:

Exploratory Data Analysis and Preprocessing

Input and output compiled into structured

Input and Output Selection and Feature Engineering

Process variables screening. Laboratory assays chronological synchronization under the assumption of steady-state daily operation *(daily value / 24= hourly value)*

Data Cleaning

Extreme outliers exceeding physical boundaries or operational anomalies caused by instrument noise/maintenance filtered out.

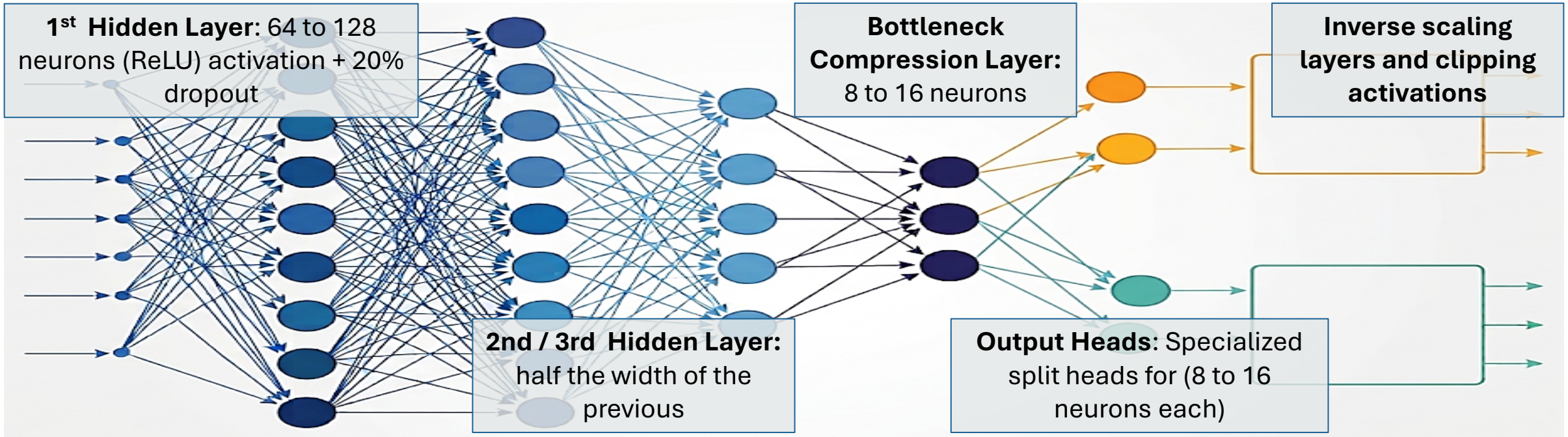
Normalization

Continuous variables scaled using Min-Max within the $[0,1]$ interval to facilitate neural network convergence.

NN MODELS

Physics-Constrained Neural Network Architecture and Implementation:

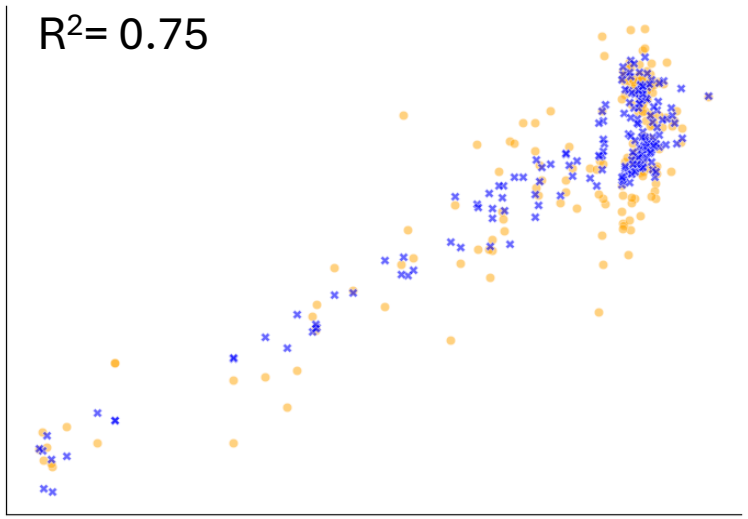
- Discrepancies in sample sizes in outputs → multi-head architecture was implemented
- Physical values → activation constraints applied in the final layers

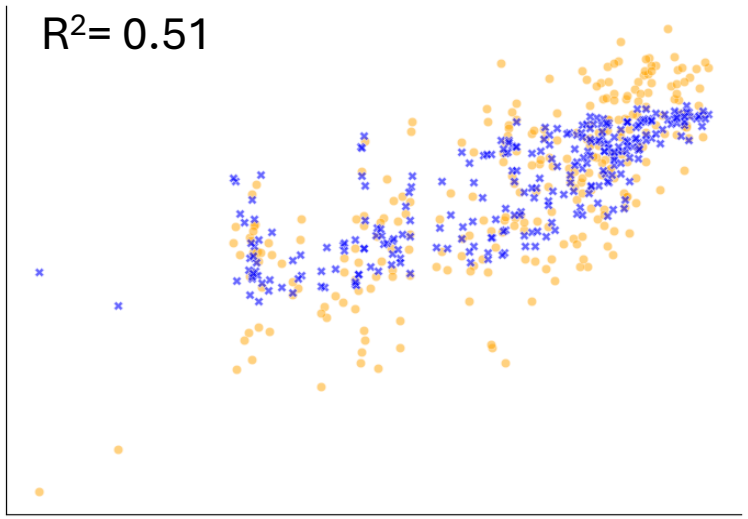


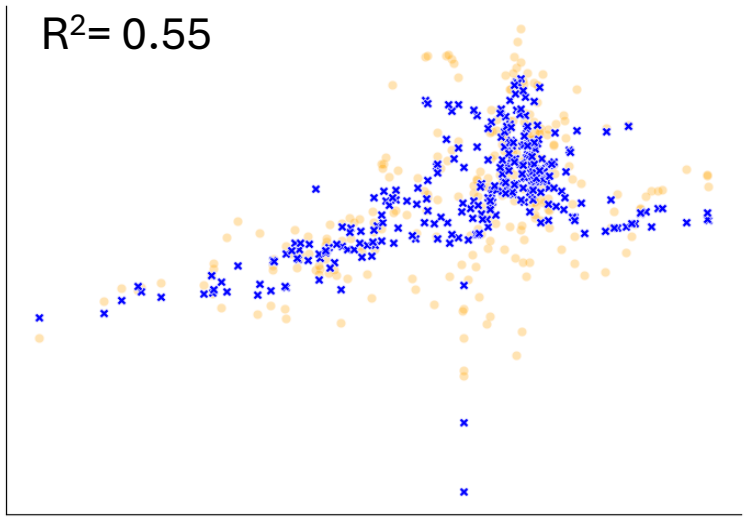
Model Training: 80% training ; 20% for validation

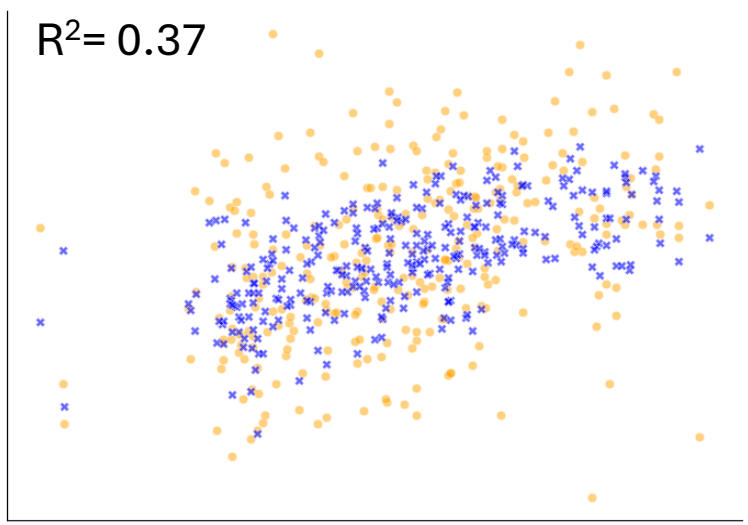
Error Estimation

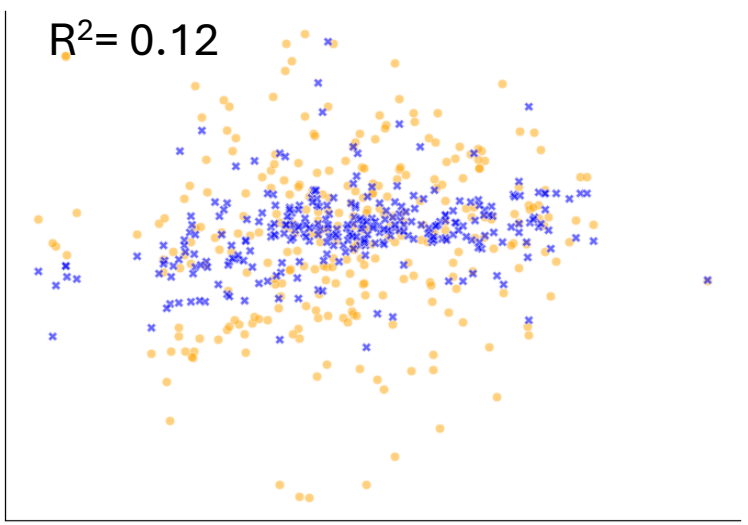
SIMULATION VS PLANT DATA

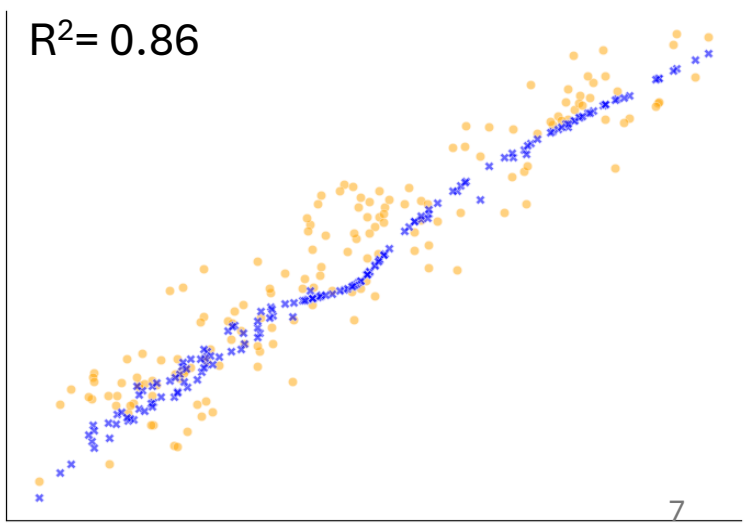








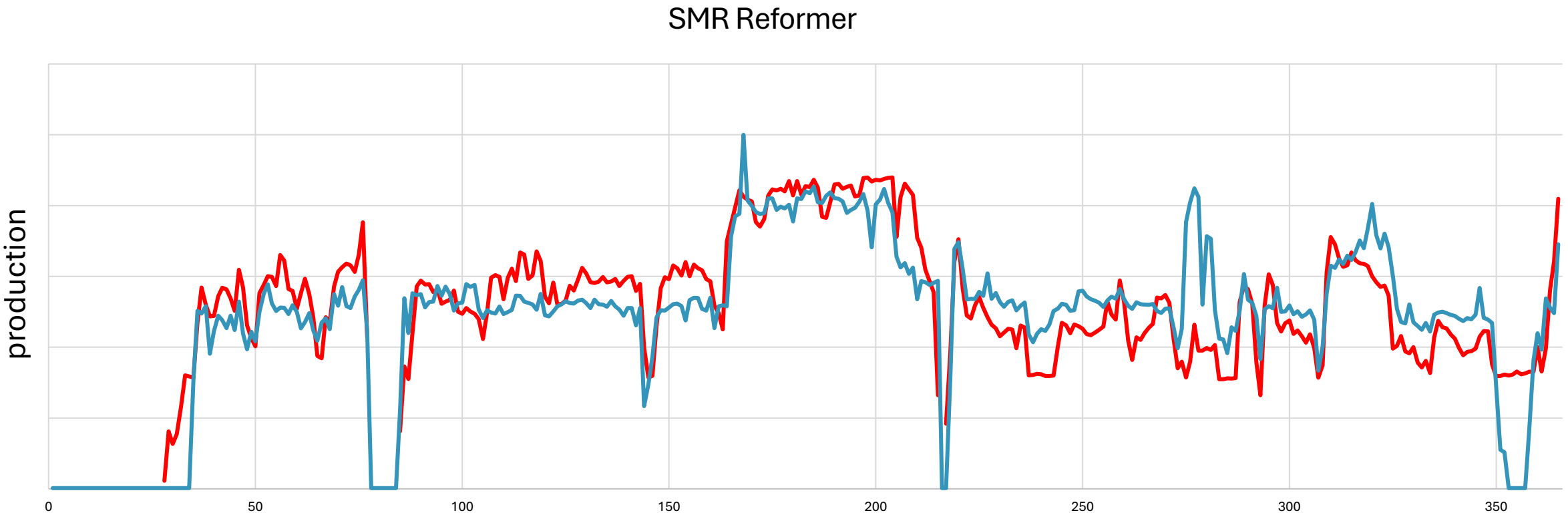




GRID NETWORK

Validation with daily operational datasets of last year:

Comparison between simulated Steam Methane Reforming (SMR) hydrogen production vs historical values.



FUTURE WORK

CURRENT RESULT

A working simulator which:

- Estimates of overall plant hydrogen demand as a function of unit operating regimes and incoming naphtha throughput.
- Accounts for the transient response constraints and ramp rates of the conventional SMR

NEXT STEPS

Using the simulator as baseline operational envelope future step will be:

- Evaluate integration of water electrolysis and hydrotreated vegetable oil (HVO) units. *(short term)*
- Study new possible consumers or green hydrogen producers
- Develop a predictive optimization for green hydrogen production

THANKS!

Universidad de Sevilla

PhD supervisors: Benito Navarrete Rubia, Pedro Haro

Catedra MOEVE – Universidad de Sevilla

Industrial supervisors: José Antonio Lucena Vargas, Antonio Gonzales Camargo

Moeve (& gráfico) es una marca registrada propiedad de Compañía Española de Petróleos, S.A, (actualmente MOEVE, S.A) la cual, se encuentra protegida en España y en otros muchos países en todo el mundo