Expanding an Open-Source Modelica-Compliant Package of Generic Renewable Energy Source Models: Implementation of the REEC_D and REGC_B WECC Models in OpenIPSL

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Abstract

Power systems undergoing large-scale renewable deployment require accurate dynamic models of inverter-based technologies such as solar photovoltaic plants, wind turbine generators, and battery energy storage systems to perform the require studies that would allow to assess and maintain power grid stability. The second generation of the Western Electricity Coordinating Council (WECC) generic renewable energy system (RES) models provides a general framework for modeling inverter-based resources in power system dynamics and stability studies. In this paper, we expand the existing Modelica-compliant open-source `OpenIPSL.Electrical.Renewables` package by implementing the Renewable Energy Generator/Converter B (`REGC_B`) model along with the Renewable Energy Electrical Controller (`REEC_D`) model, according to the second-generation WECC RES framework. Using Modelica's object-oriented features, the implementation emphasizes modularity and reusability in building scalable power system models using the OpenIPSL library. This work highlights the potential of using Modelica and OpenIPSL to support a standardized, scalable development of inverter-based RES models within the WECC framework, and extends the only fully Modelica-compliant open-source package that implements these models.
Keywords: Modelica, OpenIPSL, WECC RES models, inverter-based resources, power systems

1 Introduction

1.1 Motivation

The modeling of inverter-based resources (IBRs) is critical to ensuring reliable and realistic power system simulations, particularly with the growth of renewable energy integration. The development and validation of WECC generic RES models have played a key role in enabling dynamic studies of IBRs by different domain-specific platforms. Meanwhile, recent implementation of these models in OpenIPSL (Vanfretti et al. 2016; Baudette et al. 2018; Castro et al. 2023) using the Modelica language has demonstrated the benefits of modular object-oriented modeling for renewable energy systems (Fachini, Vanfretti, et al. 2021). Complementing this, power-hardware-in-the-loop (PHIL) testing has shown the practical relevance of the WECC framework in representing typical inverter responses under real-world operating conditions(Fachini, Chang, et al. 2025) and the value of implementing WECC models in Modelica to facilitate customization and extensibility.

However, as inverter-based systems continue to be increasingly deployed in weak grid environments, characterized by low short-circuit ratios and limited system strength, modeling accuracy becomes more critical. This is of particular importance to capture negative control interactions and potential stability issues (Adib et al. 2018; Wang et al. 2022; Mishra, Vanfretti, Delaree, and Jones 2024; Pudasaini et al. 2025). To support a more accurate representation of the inverter dynamics under such conditions, a voltage source interface model was proposed in (Ramasubramanian et al. 2016). Based on this foundation, the updated `REGC_B` and `REEC_D` models were developed to enhance the accuracy of the WECC modeling framework in dynamic performance and stability analysis of the grid. Naturally, extending our previous implementation of the WECC models in Modelica (Fachini, Vanfretti, et al. 2021) with these advancements is attractive and can provide additional benefits; including providing accurate IBR models in large-scale grid modeling that favor tools that support the Functional Mock-up Interface (FMI) standard and do not have these models in their internal libraries (Ramirez-Gonzalez et al. 2024) or provide simulation performance benefits through FMI-based parallelization (Ouafi et al. 2023).

1.2 Background and Related Works

The transformation of traditional power systems, driven by the global shift toward decarbonization and decentralization, has accelerated the integration of inverter-based resources such as solar photovoltaic (PV) plants, wind turbines (WT) and battery energy storage systems (BESS). Although crucial for enabling cleaner and flexible power systems, these sources exhibit dynamic responses that depart significantly from those of traditional generation tech-

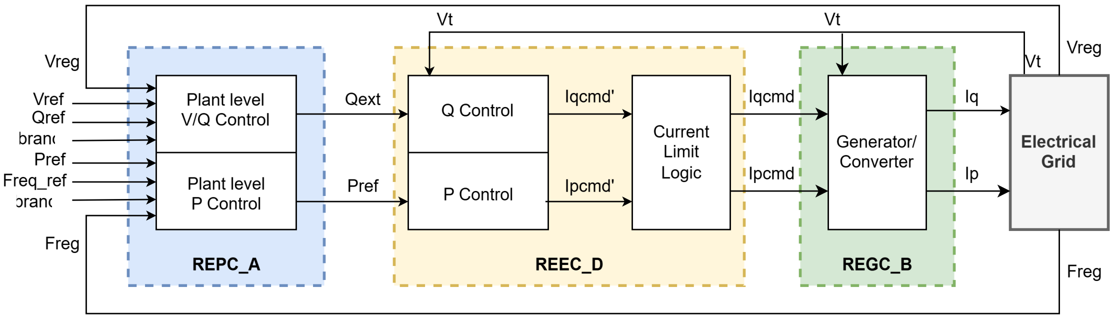

Figure 1. WECC RES Model Framework (Fachini, Vanfretti, et al. 2021)

nologies, posing new challenges to system stability and control. To address these challenges, the Western Electricity Coordinating Council (WECC), through its Renewable Energy Modeling Task Force (REMTF) (Sanchez-Gasca 2015), developed a standardized framework of second generation generic renewable energy system (RES) models for dynamic studies of inverter-based resources. Building on earlier first-generation modeling efforts, this framework aligns with broader international initiatives such as those of the International Electrotechnical Commission (IEC) (Fortmann et al. 2015), to improve modularity, broaden control representation, and support a wider range of technologies, including both wind and photovoltaic systems. Although these modeling efforts offer a consistent framework for representing inverter-based resources, their implementation in Modelica (Fritzson and Engelson 1998; Fritzson 2014) provides the added advantages of open access, modularity, and cross-platform compatibility that are not easily achieved in traditional domain-specific tools (Chang and Vanfretti 2024). When combined with the Open Instance Power System Library (OpenIPSL) (Baudette et al. 2018; Castro et al. 2023), Modelica offers a versatile and open-source language to develop standardized power system models suitable for dynamic simulation and analysis (Winkler 2017; Bhattacharjee, Vanfretti, and Fachini 2024).

The WECC RES models including the renewable energy generator / converter `(REGC_A)`, renewable energy electrical controller `(REEC_A/B/C)`, and renewable energy plant controller `(REPC_A)` were developed and validated against the commercial tool PSS®E in (Fachini, Vanfretti, et al. 2021), setting a viable proof of concept for open-source development of generic inverter-based models in Modelica using OpenIPSL. This effort led to the development of the `OpenIPSL.Electrical.Renewables` (here-forth referred as to the `*.Renewables`) package, which provides the only Modelica language-compliant and Modelica-tool–compatible implementation of the WECC Generic Renewable Energy Models — the models have been validated and tested in multiple Modelica-based simulation environments. Our implementation fully leverages templates with replaceable classes and other object-oriented features of the Modelica language, while also adopting the latest version of the Modelica Standard Library (MSL). Furthermore, the models in `*.Renewables` are compatible with multiple simulation tools such as Dymola, Wolfram System Modeler, Modelon Impact and OpenModelica, and can the models can be translated and simulated directly within these platforms. This is in contrast to other Modelica-based implementations that rely on MSL 3.2.3 and can only be viewed but not simulated in Modelica tools, requiring a domain-specific tool chain for simulation (Nuschke et al. 2021; Franke, Guironnet, and Cardozo 2024). In addition to these advantages, our present work expands the capabilities of the `*Renewables` package by incorporating the latest variants of WECC components, establishing it as the most up-to-date open-source collection of generic models of renewable energy sources available.

To support this expansion, updated versions of the WECC RES models have been introduced to better represent inverter-based resources under challenging grid conditions. The `REGC_B` model improves on `REGC_A` by introducing a voltage-source interface and enhanced current-limiting logic, offering better performance and numerical stability in weak grid scenarios. Likewise, the `REEC_D` improves upon the `REEC_A/B/C` with refined voltage-dependent limits, improved blocking, and more flexible control freeze logic (Pourbeik 2018).

This paper builds on our previous implementations of the WECC generic RES models in (Fachini, Vanfretti, et al. 2021) by extending the framework to include the `REGC_B` and `REEC_D` using the Modelica language and the OpenIPSL library. It presents a modular and reusable approach that uses Modelica's object-oriented feature to build standardized dynamic models of inverter-based resources. This work aims to extend the existing Modelica-based WECC framework and highlights how OpenIPSL can be used to support model development by leveraging open access standardization (i.e., the Modelica language), re-usability, and extensibility for power system studies.

1.3 Contributions

This paper focuses on demonstrating how key features of the Modelica language and the OpenIPSL library can be used to implement and extend standardized WECC RES models for power system studies. Thus, the contributions of this paper are as follows:

DOI
10.3384/ecp218233

- To implement next generation WECC RES models using the OpenIPSL Modelica Library.
- To exploit the replaceable template in Modelica to build the integrated models.
- To demonstrate the simulation setup and verify the features implemented in the new models.

1.4 Paper Structure

This paper is structured as follows. Section 2 describes the development of the new WECC generic models. In Section 3, we explain how Modelica is leveraged to integrate the new models within the WECC framework implemented in OpenIPSL. Section 4 illustrates the experimental setup and the simulation result. Finally, Section 5 concludes the work.

2 Development of the new WECC Generic Renewable Energy Models

Accurate representation of renewable energy sources based on inverters in dynamic power system studies requires standardized and adaptable modeling frameworks. The WECC generic RES models fulfill this need through a modular architecture that separates system-level coordination, electrical control, and grid interfacing into distinct components, as shown in Figure 1. At the plant level, the REPC_A module manages voltage and frequency regulation by generating real and reactive power references in response to system conditions. These references are passed to the electrical control module, historically modeled by REEC_A/B/C, which translates them into active and reactive current commands. Finally, the REGC_A generator/converter model interfaces with the grid, injecting current based on these commands. Although effective under normal operating conditions, this model structure lacks certain capabilities required to accurately simulate inverter behavior during certain types of faults, grid disturbances, or in weak-grid environments. To address these limitations in simulating realistic inverter behavior under faults and weak-grid conditions, the WECC framework has introduced more advanced controller and converter models —REEC_D and REGC_B. Figure 1 illustrates the updated RES modeling framework, which retains the original modular structure while replacing REEC_A/B/C and REGC_A with their improved counterparts.

This section discusses the development of the new models - REEC_D and REGC_B implemented in the Modelica language and integrated into the OpenIPSL library, following WECC specifications and ensuring compatibility with existing plant-level controllers such as REPC_A.

2.1 REGC_B Generator/Converter Model

The REGC_B model serves as the generator/converter component within the second-generation WECC generic RES framework. It replaces the earlier REGC_A model and introduces functional enhancements that improve the accuracy and numerical stability of inverter-based resource

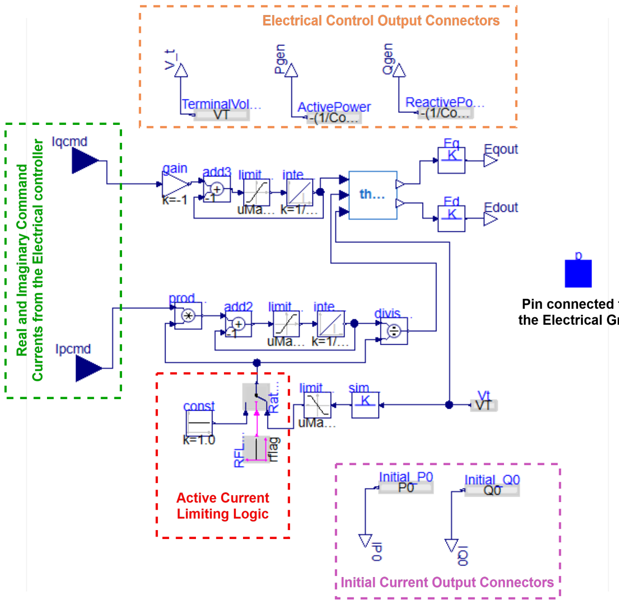

Figure 2. REGC_B model in Modelica and OpenIPSL

(IBR) simulations, particularly under conditions involving grid disturbances and low short-circuit strength.

The original REGC_A model is based on a current-source representation, wherein the model directly injects active (I_p) and reactive current (I_q) into the network. While effective under strong grid conditions, it has two key limitations. These include ignoring the voltage and impedance at the connection point; which leads to poor performance in weak grids with low short-circuit ratios (SCR), often causing numerical instability in domain-specific tools that are limited to fixed time-step solvers such as the trapezoidal integration method. According to the WECC REMTF, REGC_A becomes unreliable when the SCR drops below 2–3, frequently requiring artificial numerical stabilization measures.

To address these limitations, REGC_B, as shown in Figure 2, models the converter as a voltage source. The transition from REGC_A to REGC_B introduces several key enhancements aimed at improving numerical stability, dynamic performance, and modeling flexibility under weak grid conditions. The essential ones are as follows:

- **Voltage-Source Interface:** REGC_B replaces the current-source representation of REGC_A with a voltage source interface, improving behavior in low short-circuit ratio (SCR) scenarios. The injected current is computed using:

$$\vec{I}_{dq} = \frac{\vec{E}_{dq} - \vec{V}_t}{R_e + jX_e}$$

- **Active Current/Power Rate Limiting:** REGC_B introduces a RateFlag to select between active current or power ramping, using a rate limit parameter

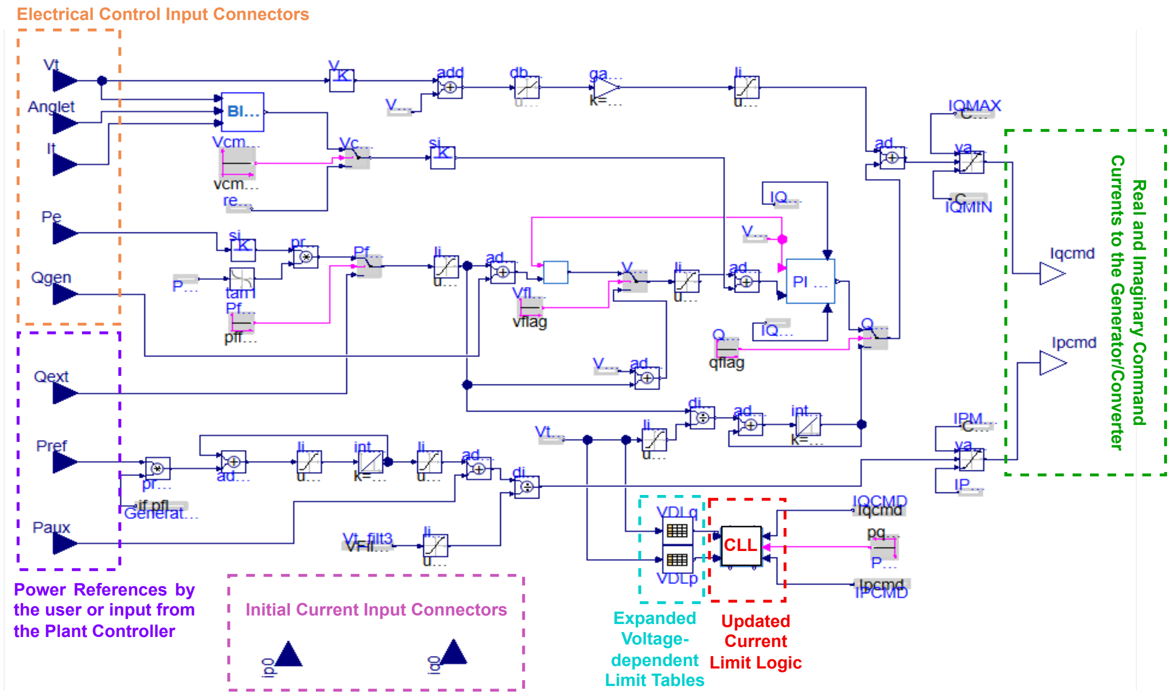

Figure 3. REEC_D model in Modelica and OpenIPSL

`rrpwr`. For current ramping:

$$\frac{dI_p}{dt} = \begin{cases} +rrpwr & \text{if } \frac{dI_p}{dt} > rrpwr \\ -rrpwr & \text{if } \frac{dI_p}{dt} < -rrpwr \\ \frac{dI_p}{dt} & \text{otherwise} \end{cases}$$

- **Removal of LVPL Block:** The LVPL block present in `REGC_A` is removed, as its behavior is now handled more effectively in upstream control logic (e.g., `REEC_D`).
- **Reactive Current Rate Limiting:** Ramp rate limits are also applied to the reactive current path, using bounds defined by `Iqrmax` and `Iqrmin`.
- **Current Magnitude Limiting:** The total current output is constrained by a maximum limit `Imax`. Priority between active and reactive current is set using `pqflag`, with:

$$I^2 = I_p^2 + I_q^2 \leq I_{\max}^2$$

when this limit is exceeded, the model applies prioritization logic (via the `pqflag`) to limit either I_p or I_q, depending on the configuration. This algebraic approach avoids the need for dynamic differential limiters and improves the simulation performance.

Together, the voltage-source interface and current-limiting logic enable `REGC_B` to operate reliably in low SCR environments (SCR ≈ 1), respond more accurately to fault conditions, and avoid numerical convergence issues common to current-source models. These enhancements make `REGC_B` a more robust and practical choice for dynamic simulation of inverter-based resources.

2.2 `REEC_D` Electrical Controller Model

The `REEC_D` model builds on the structure of the earlier electrical controller model `REEC_A`, introducing a more flexible framework for handling voltage-dependent behavior. `REEC_D` integrates a flexible set of control mechanisms, including an improved current limiting logic that allows a more realistic representation of inverter behavior under abnormal or low-voltage grid conditions. Figure 3 illustrates the entire model in Modelica using OpenIPSL. It shows key input signals such as *Pref*, *Qext*, *Pe*, and *Qgen* and the resulting current commands *Ipcmd* and *Iqcmd* that are fed to the generator/converter model. Internal blocks such as the updated current limit logic and expanded voltage-dependent limit tables are highlighted to show their roles. These advancements are discussed below.

- **Expanded Voltage-Dependent Limit (VDL) Tables:** `REEC_D` defines both reactive and active current limits using 10-point VDL tables:

$$\texttt{VDLq} = \{(V_{q,i}, I_{q,i})\}, \quad i = 1, \ldots, 10$$

$$\texttt{VDLp} = \{(V_{p,i}, I_{p,i})\}, \quad i = 1, \ldots, 10$$

Expanding the tables allow detailed shaping of the inverter's current response to different voltage levels.

DOI 10.3384/ecp218233

- **Enhanced Current Limit Logic:** The new limit equations are defined as:

$$I_{q\max} = \min(\mathrm{VDL}_q, I_{\max})$$

$$I_{q\min} = \begin{cases} I_{q\max}, & I_{q\max} < 0 \\ -I_{q\max}, & \text{otherwise} \end{cases}$$

$$I_{p\max} = \min(\mathrm{VDL}_p, \sqrt{I_{\max}^2 - I_{q\mathrm{cmd}}^2})$$

$$I_{p\min} = -K_e \cdot I_{p\max}$$

To implement these limit equations, a new logic as shown in Listing 1 was developed. It enables the model to distinguish between the generator and storage behavior by adjusting the lower active current limit based on the parameter K_e, allowing absorption of active power when $K_e > 0$. Furthermore, it ensures consistent handling of reactive power limits during high-voltage events by forcing $I_{q\min}$ to match a negative $I_{q\max}$, improving the model response under extreme conditions.

Listing 1. Enhanced Current Limit Logic in the REEC_D Model

```
model CLL_REECD "Current limit logic
    for REECD"
...
equation

Iqmax = if pqflag == false then min(
    VDLq_out, Imax) else min(VDLq_out,
    sqrt(Imax^2 - Ipcmd^2));
Iqmin = if Iqmax < 0 then Iqmax else -
    Iqmax;
Ipmax = if pqflag == false then min(
    VDLp_out, sqrt(Imax^2 - Iqcmd^2))
    else min(VDLp_out, Imax);
Ipmin = -Ke*Ipmax;
```

- **Local Current Compensation Block :** In this new electrical controller model there is a dedicated block to compensate for current measurement delays using the expression

$$|V_t - (R_c + jX_c)I_t|.$$

This helps stabilize the inverter response by correcting for dynamic errors due to measurement lags or system impedance, which is especially important for grid-tied converters.

- **The Baseload Flag :** The baseload flag feature allows control over how the power output of the inverter behaves. With the flag set to 0, the model operates normally. When set to 1, the output is capped at the initial power level P_{gen0}, allowing only reductions. If set to 2, the output is fixed to P_{gen0}.

3 Leveraging Modelica's Object Oriented Features for Open-Source Generic RES Models

This section discusses the benefits of using Modelica to implement the generic RES models in OpenIPSL, particularly through its support for the development of model architectures that provide modularity and object-oriented design. One of the key features leveraged in this work is the use of `replaceable` classes, which enable the substitution of flexible components and system reconfiguration. Figure 4 shows the structure of the `OpenIPSL.Electrical.Renewables` package, where control components such as the plant controller, electrical controller, and generator/converter are organized into distinct subpackages, supporting a clean and extensible modeling architecture for renewable plant systems.

3.1 Replaceable Template-Based Modeling of the WECC Modules

A key advantage of using Modelica in this work is the use of `replaceable` classes. This feature enhances flexibility and modularity in system design. Figure 4 illustrates the PV plant, enclosed in the red dotted box, where the modules REPC_A, REEC_D, and REGC_B are visually represented as gray highlighted blocks, indicating their implementation as `replaceable` classes in Modelica. The `RenewableElectricalController` block is highlighted in a green box to emphasize this concept, although the replaceable structure applies equally to the other modules. This approach is further illustrated in the Listing 2, where the `RenewableElectricalController` is declared as `replaceable` in the text layer, allowing flexible reconfiguration of renewable plant components in accordance with WECC modeling guidelines. This flexibility is especially valuable when evaluating multiple converter configurations or when integrating new control strategies. It allows for rapid model customization, making it well suited for system-level studies where converter behavior may vary based on application or test conditions. The modeling approach adopted here builds on principles demonstrated in our previous work on generation units using OpenIPSL and Modelica's object-oriented architecture (Fachini, Bhattacharjee, et al. 2023). While that work focused on synchronous generation units, the current model extends the concept to detailed representation of power converter units, further validating the usefulness of `replaceable` templates for scalable and reusable component modeling.

Listing 2. `Replaceable` Declaration of the `RenewableElectricalController REEC_D` in the `PV Plant` Model

```
model PV "Framework for a photovoltaic
    plant including controllers"
....
replaceable OpenIPSL.Electrical.Renewables.
    PSSE.RenewableElectricalController.
    BaseClasses.BaseREECD
```

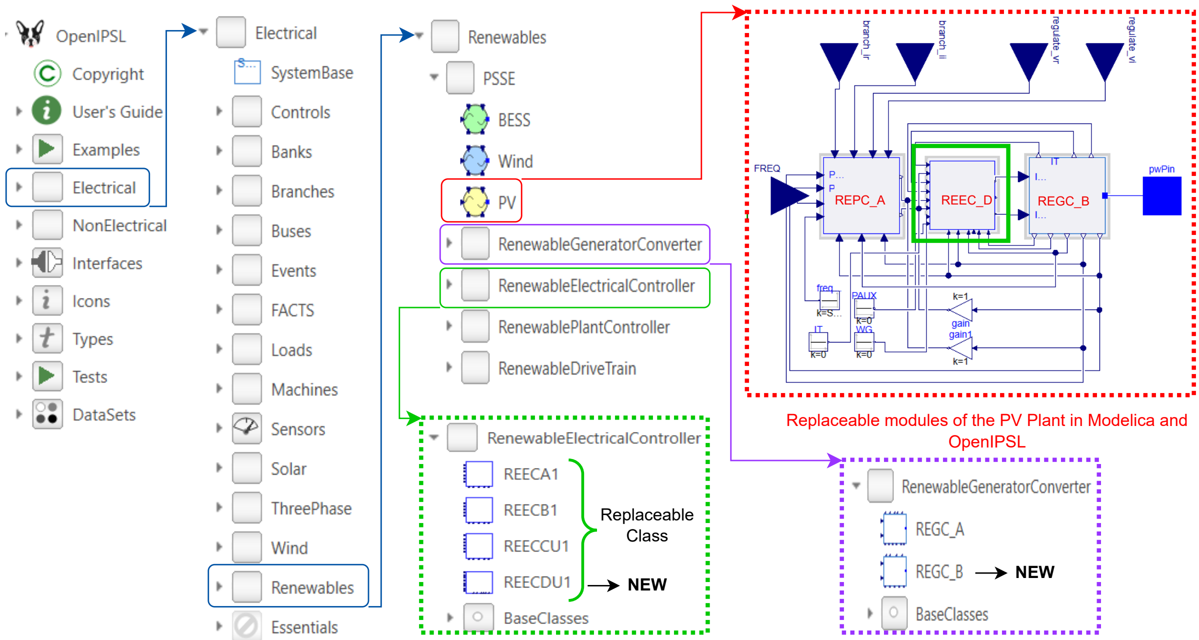

Figure 4. The `OpenIPSL.Electrical.Renewables` Package Structure

```
    RenewableController(
    pfflag=pfflag,
    vflag=vflag,
....
end PV
```

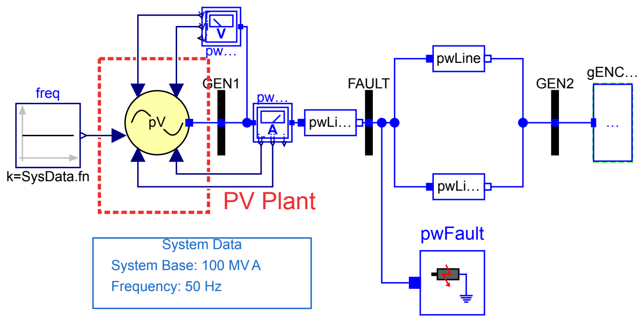

Figure 5. PV Plant in an SMIB Test Setup in OpenIPSL

3.2 Utilizing the Switch Component in Modelica for Current Limit Logic

The implementation of the `RateFlag` in the `REGC_B` model marks a key improvement over the `REGC_A` by introducing logic that allows the rate limit to apply either to active-current (*Ip*) or to active-power (*P*), depending on the value of the flag. When `RateFlag = 0`, the logic enforces a rate limit on the current ramp (*Ip*), and when `RateFlag = 1`, it enforces it on active power. This distinction reflects practical considerations, as some vendors implement rate limits in terms of power rather than current. The flexibility of Modelica enables this logic to be cleanly embedded using graphical components such as the `Logical.Switch` block, which conditionally routes the signal based on the Boolean value of the `RateFlag`. As shown in Figure 2, the section marked with red dotted lines labeled "Active Current Limiting Logic" implements the `RateFlag` functionality. The use of a `Switch` block in Modelica enables seamless routing between control paths based on the flag value, without repeating the code in the text layer.

4 Results

4.1 Simulation Model Configuration

The components built in Sections 2 and 3 are arranged and connected as shown in Figure 4, forming the internal structure of the PV plant. Then this PV plant model as highlighted within the red dotted block in Figure 5 is tested by integrating it into a single machine infinite bus (SMIB) test system. A similar model can be set for other models, such as BESS or Wind Plant, simply by making changes to existing templates in OpenIPSL, `*.Renewables.BESS` or `*.Renewables.Wind`, and setting control flags according to the WECC guidelines.

The setup in Figure 4 introduces a three-phase fault from ground to ground through the `pwFault` component of OpenIPSL allowing for evaluation of their dynamic response under grid disturbances. The system includes three transmission lines (`pwLine`, `pwLine1`, and `pwLine2`) with defined impedances. The bus `GEN2` is connected to an infinite bus model from OpenIPSL that represents the connection to the grid.

4.2 Comparing `REEC_B` vs `REEC_D`

Next, the voltage response and fault dynamics are analyzed to validate the behavior of the model under grid disturbances when using the existing `REEC_B` vs. the newly implemented `REEC_D`. The results are verified through

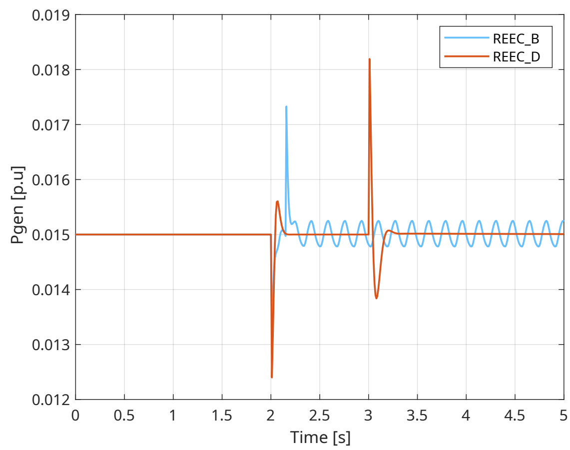

Figure 6. Active Power generated by the PV Plant in OpenIPSL, comparing the response of the new REEC_D model vs the previous REEC_B model.

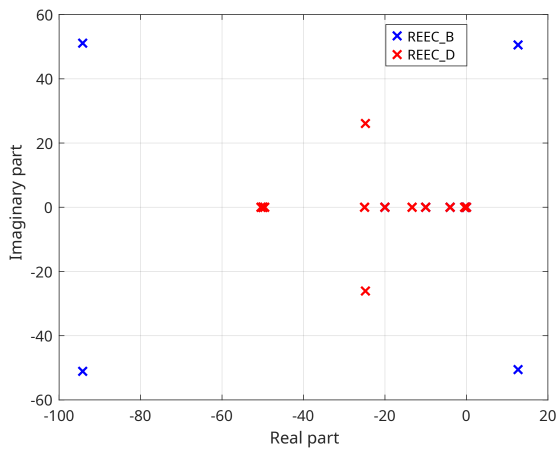

Figure 7. Poles of the PV plant comparing the REEC_B and REEC_D controllers

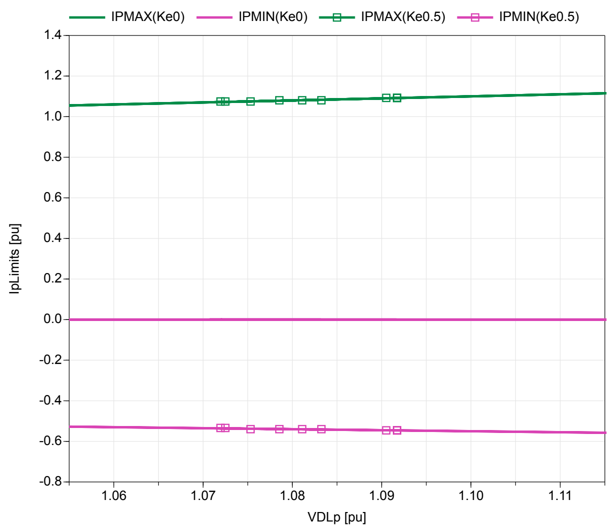

Figure 8. Active Current Limits for $K_e = 0$ and 0.5 based on the expanded VDL$_p$ table.

linear analysis of the two model variants.

Figure 6 shows the active power output P_{gen} of the REGC_A converter model along with the newly implemented controller REEC_D (in red), along with the response of the REGC_A with the previous controller REEC_B (in blue). The simulation scenario subjects the power system to a fault at the FAULT bus (see Figure 5), which occurred around 2 seconds and lasted for 1 second. Observing the red trace, which corresponds to the use of the new controller model REEC_D, during the application of the fault, there is a sharp deviation in P_{gen}followed by a transient response as the system stabilizes. After the event, the power gradually returns to its steady state, indicating the system's ability to recover from the fault. It should be noted that the blue line that corresponds to the response when simulating the use of the REEC_B controller results in a growing oscillatory response during the fault, along with a critically stable response after the fault. This shows one of the main benefits for simulation accuracy that the new model offers.

Figure 7 illustrates the linear analysis of the PV plant test model as shown in Figure 4. The poles of the model with both the electrical controllers, REEC_D and the previous version REEC_B, are compared. It can be observed that the REEC_B model, exhibits an unstable pole, which is not present in the newly implemented REEC_D model. This is also reflected in the Table 1 where the REEC_D model shows poles with lower frequency (5.73 Hz) and moderate damping (0.6889), indicating slower, well-damped oscillations. In contrast, the REEC_B model has a pair of poles with a higher frequency (8.3 Hz) and negative damping (-0.2433), which explains the oscillations as seen in Figure 6. Observe that although this is an unstable pole, the states that affect are internal to the plant, that is, the plant controller and the renewable energy controller, as indicated in the contribution to states column in Table 1. Consequently, this results in the oscillatory response in Figure 6, and because in the test model it does not interact with other dynamic components, the power system will not become unstable. This is the effect of modeling the "infinite bus", which absorbs the oscillations injected by the PV and does not interact with it. This bounded response when interfacing a power electronic device with a strong network has recently been observed for the case of PV plants (Wang et al. 2022) and data centers (Mishra, Vanfretti, Delaree, Purcell, et al. 2025), and therefore care should be taken when choosing when to use REEC_B or REEC_D, and/or, how they are parameterized in order to capture this behavior if appearing in a particular plant.

4.3 Illustrating New Model Features of REEC_D

Figure 8 illustrates the verification of the enhanced current limit logic based on the expanded voltage-dependent limit table implemented in the REEC_D model, as defined in Listing 1. The plot shows the active current limits (Ipmax and Ipmin) for two configurations: $K_e = 0$ and $K_e = 0.5$, plotted against the voltage-dependent limit out-

Conjugate Pair number	Eigen Value	Freq. [Hz]	ζ	Contribution to States
Model: REEC_D				
19/20	$-24.795 \pm j26.09$	5.7284	0.6889	z[19/20] $\rightarrow$ `PlantController.leadLag.TF.x_scaled[1]` (73 %) z[19/20] $\rightarrow$ `PlantController.simpleLag2.state` (8.7%)
Model: REEC_B				
18/19 & 16/17	$12.68 \pm j50.55$	8.2959	-0.2433	z[18/19] $\rightarrow$ `PlantController.leadLag.TF.x_scaled[1]` (41%) z[16/17] $\rightarrow$ `RenewableController.integrator2.y` (25.5%)

Table 1. Complex conjugate pairs of eigenvalues and their contributions for REEC_D and REEC_B models.

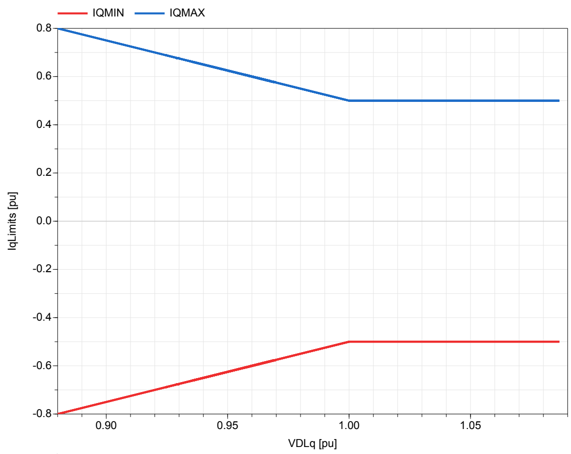

Figure 9. Reactive Current Limits for $K_e = 0$ based on the expanded VDL$_q$ table.

put, VDL$_p$. The results are consistent with the expected behavior presented in the WECC report introducing the model (Pourbeik 2018), where the maximum current (`Ipmax`) remains unchanged in both cases, reflecting its independence from the K_e parameter.But the minimum active current (`Ipmin`) varies with K_e, remaining at zero for $K_e = 0$, which corresponds to a generator that allows discharging only, with no charging capability. In contrast, for $K_e = 0.5$, `Ipmin` is around -0.5 while `Ipmax` remains around 1.0, reflecting a storage device and indicating that the it can charge at half the maximum discharging rate. This is clearly reflected in the plot, where the `Ipmin` curve for $K_e = 0.5$ reaches half the magnitude of the corresponding `Ipmax`.

Similarly, Figure 9 compares the implemented reactive current limits (`Iqmax` and `Iqmin`) in the model against the expected behavior defined by the VDL$_q$ table. The simulated curves closely follow the voltage-dependent shape of the reference table which confirms that the model correctly applies the VDL$_q$ logic to constrain the reactive current based on terminal voltage. The observation made on both Figures 8 and 9 is verified by the results reported in the WECC documentation (Pourbeik 2018).

5 Conclusions

This work demonstrates the effective use of Modelica and the OpenIPSL library to implement the second-generation WECC generic renewable energy system models, specifically the generator/converter `REGC_B` and the electrical controller `REEC_D` components. Leveraging replaceable template-based modeling in Modelica allowed us to build flexible and modular models that can adapt to different simulation needs without changing the base structure. This approach supports faster testing and better customization, especially when working with different converter setups. The use of the `RateFlag` in the `REGC_B` model added a practical and important improvement by allowing the model to switch between limiting based on current or power. This logic was built using Modelica's `Switch` component, which simplifies the design by clearly separating control paths and makes the model easier to trace and modify through its visual interface. Overall, the combination of Modelica and OpenIPSL offers a strong and reusable way to model inverter-based resources and supports more accurate and scalable studies of power system dynamics.

In future work, we will develop new power grid models that would allow us to better illustrate the behavior of the generator/converter `REGC_B`, with a particular focus on presenting its results, as it is specifically designed to handle weak grid conditions. We will also examine the electrical controller `REEC_D` under different SCRs and compare them against the previous models in order to illustrate the benefits mentioned in the `WECC` reports (Pourbeik 2018).

To access the models in this paper before they are integrated into OpenIPSL, the reader can find them in the following GitHub repository: `https://github.com/ALSETLab/OpenIPSL_IMC2025WECC`

Acknowledgements

This paper is in part, based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Industrial Efficiency and Decarbonization Office, Award Number DE-EE0009139, and in part by the National Science Foundation Award No. 2231677.

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