Financing Renewable Energy Infrastructure in Croatia

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Abstract: This paper is motivated by the on-going policy debate on renewable energy development. It first aims to evaluate the current options for financing renewable energy infrastructure in Croatia. It consequently suggests innovative financial concepts that proved to be successful in facilitating renewable energy based technological change in several European Union countries. Using the indicator-based approach, the results suggest that Croatia is still lagging behind the European Member States with respect to renewables development. Therefore, Croatian policy decision-makers in renewable energy sector should reconsider the current level of financial and fiscal support provided for renewables.

Key-Words: public finance, financial instruments, renewable energy resources, energy policy, renewable energy technologies, sustainability.

1 Introduction

Fiscal and monetary policies have an important role in facilitating the transition from conventional to renewable energy (RE) electricity infrastructure in a particular country. The policy-decision makers are faced with multiple challenges when determining the optimal financial and fiscal support for investing in RE infrastructure. These decisions require a comprehensive prior research, as it is important that all potential indirect impacts of RE development: political, economic, social, technological, and environmental, are considered. This paper observes the national patterns related to building RE infrastructure in the new European Union (EU) member state, Croatia. Croatia is chosen as a country of interest since it has to revise its environmental legislation to reach the EU well-known 2020, 2030, and 2050 climate change targets. In particular, GHG emissions should be reduced by 20 % until 2020, by 40 % until 2030 and by 80-90 % until 2050 in comparison with 1990. Second, the share of energy consumption from RE should increase by 20 % until 2020 and by 27 % until 2030 in comparison with 1990. Third, energy efficiency should increase by 20 % until 2020 and by 30 % until 2030 in comparison with 1990 (European Commission, 2009; 2011; 2014). In order to examine Croatian potential for reaching these targets, this research focuses on different country indicators: country RE resources, support schemes for RE electricity, CO_2 emissions, revenues collected from environmental taxes, total net electricity consumption, total net RE electricity consumption, hydro, wind, solar, biomass, and geothermal energy production, multiple policy documents and acts aimed at supporting RE. The relevant data is collected for the period from 1992 until 2012, based on the availability of data for constructing a particular indicator. The results of the analysis reveal that Croatian RE policy is more oriented on providing a support for RE technological diffusion than for innovation activities. Observing the scenarios in EU leading countries in RE, providing a higher R&D support for RE innovations would lead to consequent faster development of RE infrastructure in Croatia. The paper is organised as follows: Section 2 provides a literature review on different countries' successful solutions and barriers related to development of national RE infrastructure. Section 3 discusses the Croatian RE resources and potential. Section 4 describes the methodological approach and data collected. Section 5 presents and discusses the indicator-based results. Final Section 6 concludes by summarizing the policy recommendations aimed at facilitating the Croatian RE infrastructure. The last Section 6 additionally identifies the research limitations and suggests the avenues for further research.

2 Literature Review

This section provides a critical review of literature on financial support provided in several EU countries for development of RE infrastructure. Review of literature is organized in a way that it first presents the good examples of financing RE infrastructure in a particular EU Member State. The

review is then followed by discussion on the level of relevant support provided for Croatian RE infrastructure development. The analyses conducted so far usually focus on the impact of ***financial RE policy support measures*** in facilitating development of RE infrastructure. In general, several studies (e.g. Pristupa and Mol, 2015; Dombrovski, 2015; Abolhosseini and Heshmati, 2014; European Commission, 2014; Simsek and Simsek, 2013; Roy et al., 2013; Perry, 2012; Jaccobson and Lauber, 2006) suggest reconsidering the financial support mechanisms for technological investments. Perry (2012) takes Mauritius as a case study to provide an example on how current countries' fiscal systems could be reformed to better address negative externalities. Perry (2012) emphasizes that fiscal instruments such as environmental taxes are the most effective and efficient in addressing externalities, especially those related to transport. Simsek and Simsek (2013) evaluate recent incentives for RE in Turkey and review several successful EU country examples (UK, Denmark, Germany) with respect to incentives these countries use (see Table 1) to foster a source specific RE diffusion. Abolhosseini and Heshmati (2014) contribute to the debate on the most popular governmental incentives used to finance RE development programs: FITs, tax incentives and tradable green certificates. Pristupa and Mol (2015) contribute to the recent literature on RE financing and development by explaining the reasons behind the limited development of a Russian bioenergy sector. Russia will have to overcome the problems of lack of knowledge on RE and insufficient market conditions to achieve the requirements of the Energy Strategy 2030 (Ministry of Energy of the Russian Federation, 2010). One of the main policy recommendations that emerged from research by Roy et al. (2013) is that country's fiscal policy should better subsidize domestic financial investments in RE technologies. The author further emphasize that private investments and novel fiscal instruments can support the transition toward RE. Countries with an optimal choice of fiscal instruments in force, such as Sweden, Denmark and Germany, motivate firms to increase their investments in RE. On the other hand, the absence of suitable fiscal policy support for RE in e.g. Netherlands, cause firms to stop investing in a particular RE source, although the RE technology infrastructure is in place (Jaccobson and Lauber, 2006; Roy et al., 2013).

In addition to financial incentives for RE, it has been emphasized that more focus should be put on examining these policy impacts on ***financial citizen participation in RE infrastructure*** development. In that regard, Yildiz (2014) discusses the various financing concepts, i.e. business models of citizen participation in financing RE infrastructure in Germany. Recent studies (UNDP Croatia, 2014) show that development of Croatian RE infrastructure is subsidized (through feed in tariff) from a fund that collects fees from citizens through their electricity bills. According to the UNDP Croatia (2014) more than 50% of RE sector in Germany is owned by RE cooperatives and citizens. In Croatia, citizens and local community have a minimal role in developing RE infrastructure, i.e. citizens' participation is limited to development of solar power, and is only 6%. The set of guidelines for encouraging citizens' participation in developing Croatian RE infrastructure (UNDP Croatia, 2014) could be summarized as follows:

1. Citizens could own shares in new RE projects;
2. A 200 MW quota should be provided for subsidizing citizens' or local authorities' owned projects;
3. Current Feed in Tariff (FIT) based on quotas should be replaced with RE support schemes based on net metering for solar PV up to 30kW;
4. Policy decision-makers should adopt a national strategy for increasing the share of citizens' ownership in RE infrastructure;
5. Members of cooperatives should have an opportunity to retain the unemployment incentives;
6. Cooperatives should be exempted from taxes on reinvested profit;
7. Grid connection costs for solar PV technologies should be reduced.

These guidelines would facilitate the cooperative projects that have a significant role in developing a country's economy, in increasing a local employment, in decreasing a country's energy dependence and in raising a societal environmental awareness.

3 Croatian RE Potential

This section provides the essential information on potential of RE sources in Croatia. Croatia has geographical and climate advantages that contribute to faster utilization of its different RE sources, such as: hydro, wind, solar, biomass and geothermal (Majandžić and Jerkić, 2013). However, despite of its RE potential, Croatia is an energy importing country, and 56.38% (according to the World Bank

data for 2012) of its energy demand is met by energy import. Therefore, Croatian RE policy should put more efforts in encouraging climate for investing in RE instead of further relying on energy import to the same extent. Utilization of its RE potential could decrease county's CO_2 emissions and improve its security of energy supply.

Considering the specific RE sources in Croatia, hydropower is the most widely utilized source of RE. Identification of **wind** characteristics reveals that Croatia has sufficient potential for wind technologies development. Data on wind potential presented in the paper by Pašičko et al. (2012) reveal that technical wind potential estimates in the continental part of Croatia reach 10 TWh, and 12 TWh in the Mediterranean part of the country. Wind speed, direction and frequency characteristics have shown that Adriatic region has more potential for wind technologies development than continental part of the country. **Biomass** potential includes the wood biomass, agriculture biomass, and firewood cultivation. Croatia is one of the countries with the large biomass potential (Energy Strategy of the Republic of Croatia, 2009). Yearly country potential for electricity production from biomass is 9.39 TWh (REEEP Policy Database, 2012). The country owns such significant potential for biomass use (39 PJ) to forests that cover more than 40% of the country area, to agriculture and waste. Croatian **solar** energy potential exceeds its energy needs (Brodarski institute, 2010). It is estimated that yearly technical potential for solar thermal energy is 630 PJ and for solar PV is 33 PJ (Karadža, 2011). The potential of small **hydro** power plants is around 100 MW (Vrhovčak et al., 2006). **Geothermal** potential in Croatia is 839 MW of thermal energy and 47.9MW of electric energy (Vrhovčak et al., 2006). Although Croatia has immense RE potential, it is not sufficiently utilized (Luttenberger, 2015).

4 Methodological Approach and Data

This paper combines historical document analysis with indicators based analysis. Indicators presented to address Croatian historical RE development include: country resources, support schemes for RE electricity, CO_2 emissions, environmental tax revenues, total net electricity and RE electricity consumption, source specific energy production, policy documents and acts introduced to promote RE. Document analysis focuses on the EU and national legislation related to RE in Croatia. Documents are grouped in three categories according to the phases of the technological change process: invention, innovations and diffusion of RE. Relevant RE policy documents are observed in the period from 1990 to 2015. Data for indicators is collected for the period from 1992 to 2012. Data is collected from different statistical sources such as: the US Energy Information Administration - International Energy Statistics, EUROSTAT, RES LEGAL, Ren21, IEA/IRENA.

5 Results and Discussion

Croatian RE legislation has been aiming to substantially follow the EU acts. However, there is still discrepancy between the RE policy aims and the levels of RE electricity generation achievements.

Table 1: Support schemes for RE electricity

	FIT	RPS	TENDER	TAX INCENTIVE/ INVESTMENT GRANT
AT	+			
BE		+		
BG	+			
CY	+			+
CZ	+			
DK	+			
EE	+			
FI	+			+
FR	+		+	
DE	+			
GR	+			
HU	+			
IE	+		+	
IT	+	+		
LV	+		+	
LT	+			
LU	+			
MT	+			+
NL	+			+
PL		+		+
PT	+		+	
RO		+		
SK	+			+
SI	+			
ES	+			
SE		+		+
UK	+	+	+	
HR	+			+

Note. Each row represents a policy type. AT, Austria; BE, Belgium; BG, Bulgaria; CY, Cyprus; CZ, Czech Republic; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; MT, Malta; NL, Netherlands; PL, Poland; PT, Portugal; RO, Romania; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; UK, United Kingdom; HR, Croatia.

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Source: R. Haas et al., *A historical review of promotion strategies for electricity from renewable energy sources in EU countries*, 2011; REN21, *Renewable Energy Policy Network for the 21st Century*, 2012; Res-legal, *Legal sources on renewable energy*, 2012; and IEA/IRENA, *Joint Policies and Measures database*, 2014.

Descriptive statistics (Table 2) and the subsequent set of figures are used to present the Croatian data on CO_2 emissions, environmental taxes, electricity consumption and production.

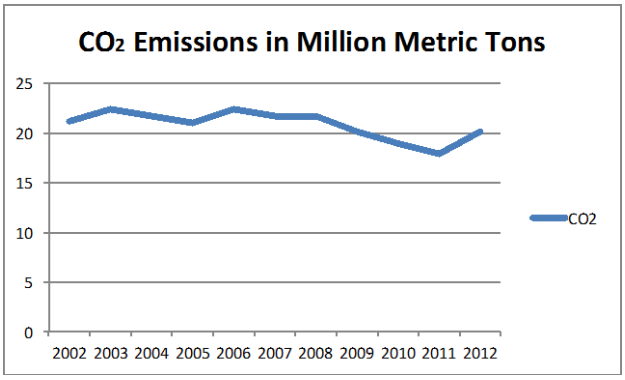
Table 2: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CO_2	21	19.76	1.78	16.58	22.39
ETR	11	1454.86	158.71	1163.71	1654.37
REC	21	5.66	1.09	4.24	8.42
EC	21	13.23	2.55	9.86	19.63
HYD	21	487.40	94.87	364.20	716.20
WIN	21	3.40	7.24	0.00	28.30
SOLT	21	1.49	2.49	0.00	7.10
SOLPV	21	0.01	0.04	0.00	0.20
BIOW	21	385.89	122.43	243.40	739.70
GEO	21	1.45	2.55	0.00	7.00

Note: CO_2 (Million Metric Tons), ETR - environmental tax revenues (Million EUR), REC - Total Net RE Electricity Consumption (Billion Kilowatt-hours), EC - Total Net Electricity Consumption (Billion Kilowatt-hours), HYD - hydro, WIN - wind, SOLT - solar thermal, SOLPV - solar photovoltaic, BIOW - biomass and waste, and GEO - geothermal energy production (thousand TOE).

Figure 1 shows that Croatia was predominantly reducing its CO_2 emissions until 2011, when emissions again started to slightly increase.

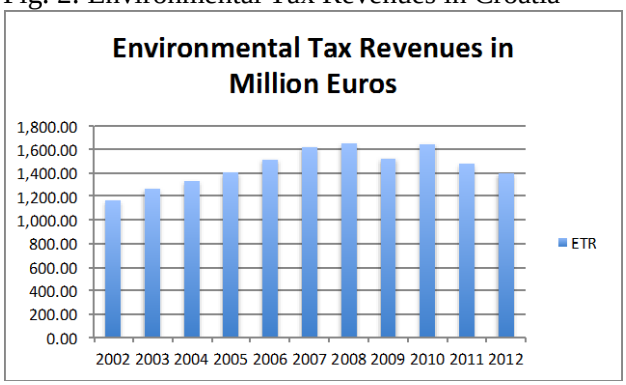
Fig. 1: CO_2 Emissions in Croatia



Source: EIA, International Energy Statistics

The subsequent figure 2 shows that the revenues collected from environmental taxes were increasing until 2008 and than started to predominantly decrease, mainly due to the global economic crisis.

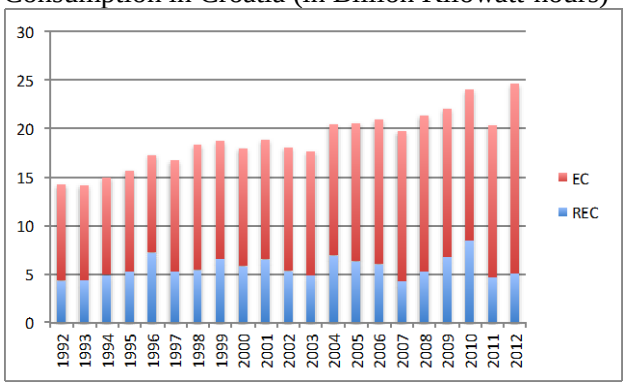
Fig. 2: Environmental Tax Revenues in Croatia



Source: Eurostat

The figure 3 presents the (still low) share of RE in total electricity production.

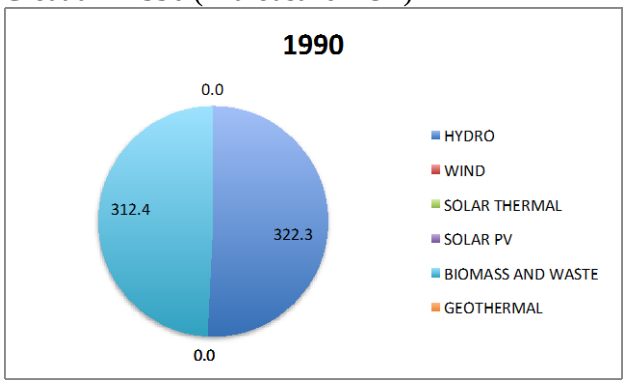
Fig. 3: Total Net Electricity and RE Electricity Consumption in Croatia (in Billion Kilowatt-hours)



Source: EIA, International Energy Statistics

Figures 4 and 5 present the source specific energy production in 1990 and 2013. Although production of energy from wind, solar and geothermal sources increased since 2004, the % of energy generated from these sources is still very low.

Fig. 4: The Source Specific RE Production in Croatia in 1990 (in thousand TOE)



Source: Eurostat

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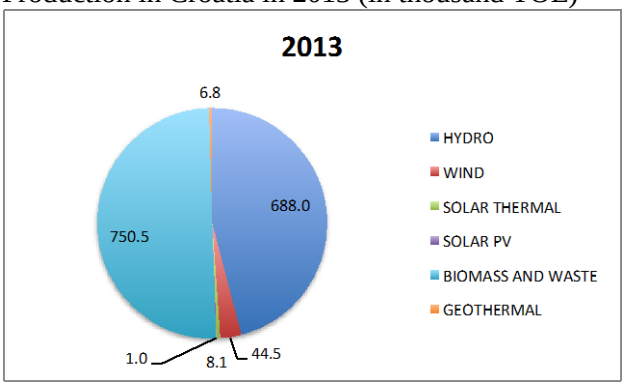
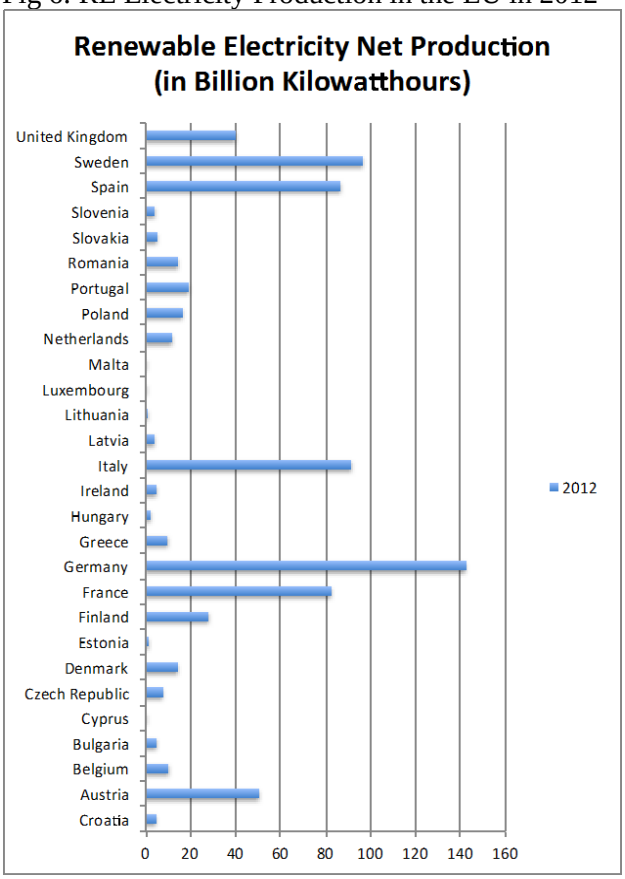
Fig. 5: The Source Specific Renewable Energy Production in Croatia in 2013 (in thousand TOE)



Source: Eurostat

Figure 6 show differences among the EU countries in RE electricity production. It can be observed that Croatia is lagging behind the majority of EU countries.

Fig 6: RE Electricity Production in the EU in 2012



Source: EIA, International Energy Statistics

Overall, the increase in CO_2 emissions in recent years, lower revenues collected from environmental taxes, insufficient share of RE in total electricity consumption and insufficient utilization of multiple RE sources in Croatia require more effective and efficient RE support incentives. Policy makers should be very careful when deciding on the level of fiscal support aimed at facilitating RE development.

In some countries, e.g. Spain and Germany, the levels of RE fiscal support instruments are higher than the RE production costs, what is the opposite to the, e.g. Finland case. If support instruments are higher than the production costs, that can facilitate faster achievement of countries' RE targets. In such case, production costs would be reduced fast, what would further cause that generators obtain more income than expected. Consequently, that places an extra burden on the public finances during the whole period in which fiscal support needs to be provided, no matter of the fact that fiscal support instruments already achieved their purpose. (Delloite, 2011; Simsek and Simsek, 2013).

The subsequent Table 3 presents an overview of the most relevant legislation that is put in force to facilitate RE.

Table 3: The most relevant energy policy documents aimed to support RE innovations and technological diffusion in Croatia from 1990 to 2015

Technological change process	Governmental intervention	Technologies addressed	Description of the governmental intervention
Inventions	No direct governmental interventions	/	/
Patents & networks	PROHES, 1994	All RES-E	Scientific-research programme for development and organization of Croatian Energy Sector
	Strategy of Development of Croatia - "Croatia in the 21st Century", 2003	All RES-E	It emphasizes the importance of the scientific activity for the development; it states that Croatia is stagnating with R&D support
	Memorandum of	All RES-E;	The programme

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	understanding for Croatia's participation in the EU programme 'Intelligent Energy - Europe', 2007	biomass & wind in particular	promotes renewable energy sources
Technol. diffusion	Energy Sector Development Strategy, 1991-2030	All RES-E	The Strategy aims to build a sustainable energy sector
	BIOEN 2007	Biomass	Biomass and waste national energy utilization programme requires at least 15% of Croatian energy needs to be derived from biomass and waste by 2030
	ENWIND 1997	Wind	Wind national energy utilization programme requires 400 MW of wind energy by 2030
	SUNEN 1997	Solar	Economic solar potential in 2020 will be 40 PJ
	MAHE 1997	Small Hydro	It is estimated that the total amount of small hydro capacity would not exceed 100 MW
	GEOEN 1997	Geother mal	The estimates for geothermal energy use in the year 2030 range from 400 to 700 TJ / year
	The Energy Sector Development Strategy of the Republic of Croatia, 1998; 2002	All RES-E	It comprises energy, economic, legislative, organisational, institutional and educational
			elements needed for fastening the Croatian successful integration into the EU
	Energy Act, 2001; 2004; 2007	All RES-E	It sets mandatory programmes for efficient energy use, which were developed by the Government: National energy efficiency programme (2008-2016) and the National energy efficiency plan of implementation (2008-2010)
	Law on the Environmental Protection and Energy Efficiency Fund, 2003-present	All RES-E	The Environmental Protection and Energy Efficiency Fund of the Republic of Croatia finances activities in three basic areas: environmental protection, energy efficiency, and the use of renewable energy sources
	HBOR Programme for Environmental Protection, 2005	All RES-E	Loan Programme for Environmental Protection, Energy Efficiency and Renewable Energy Sources
	Tariff system for the production of	Biomass and wind (plus	It defines the source specific incentives for

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	electricity from renewable energy sources and cogeneration, 2007	other renewable sources: solar, hydro, geothermal, biogas, biofuel)	electricity generated from renewable sources
	The Energy Strategy of the Republic of Croatia, 2009-2020	All RES-E	Implemented with purpose to harmonize national and the EU energy goals
	Energy Law, 2001; 2012	All RES-E	It aims to ensure efficient energy policy

Source: The authors' own compilation

Based on the analysis of the relevant RE legislation it can be concluded that Croatia could be labelled as 'an innovation adopter' country. Its policy has been more oriented on providing support for RE technological diffusion, rather than providing larger support for R&D activities.

6 Conclusion and Policy Implications

This paper analysed the Croatian RE legislation and indicators relevant for development of RE infrastructure. The main conclusion that have emerged from this analysis is that Croatia is an energy importing country and it is of high importance that it better utilizes its RE potential in order to reduce its energy import dependence. Two main recommendations for RE policy could be summarized as follows:

1. Croatian policy makers should reconsider the set of financial and fiscal support instruments aimed at facilitating development of RE infrastructure after looking into successful EU examples.

2. Croatian policy-decision makers should consider utilization of different business models for financial citizen participation in Croatia that proved to be successful in other EU countries (e.g. Germany).

Other policy recommendations. UNDP Croatia (2014) stresses the importance of improving the legal framework for enabling the Croatian community and citizen RE projects, following the good practices from Germany, Denmark, Spain or Belgium. Policy makers should also take fast actions to remove or at least minimize barriers to development of infrastructure in Croatia, such as:

- Insufficient financial resources for RE infrastructure development;
- Insecurity of financial and fiscal RE support;
- Time-consuming bureaucracy;
- Inadequate market conditions;
- Insufficient financial citizen participation in RE infrastructure development;
- Insufficient cross-national cooperation on RE projects;
- Corruptive practices in energy sector.

Further research avenues. Further research should provide more in-depth analysis of the current and potential business models for financial citizen participation in the installed RE capacity in Croatia. Further research should also include an econometric analysis of the effectiveness and efficiency of Croatian financial and other policy incentives introduced to facilitate RE infrastructure development.

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